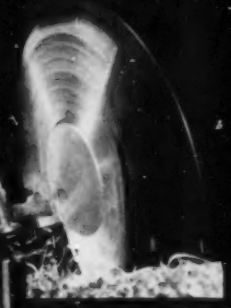
PRODUCT ENGINEERING

MAY 1951



DESIGNING FOR HISTORY'S DECISIVE DECADE

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Happy Landing Insurance...

SHARON*

STEEL DISCS ADD LIFE TO POPULAR HYDRAULIC AIRCRAFT BRAKE

It takes a lot of stopping to halt 70 tons moving at a speed of 100 miles per hour. Consequently, aircraft brakes must be tough. Among the toughest is the hydraulic disc brake. Basically, the disc brake is composed of two sets of discs, one of which is locked to the brake chassis and is non-rotating. The second set rotates with the wheel. The rotating discs are alternated with the non-rotating discs. When pressure is applied, the discs are compressed together. The friction results in braking action.

The steel used in the brake discs must withstand tremendous abrasive action even when they get hot. One brake manufacturer finds his best steel to be Sharon carbon strip steel. It resists friction wear at high heats and doubles the life of the brake.

*Specialists in STAINLESS, ALLOY, COLD ROLLED AND COATED Strip

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Sharon, Pennsylvania

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SHARONSTEEL

with Ross Full-Flo In-Line Valve you get Full Pipe Capacity!

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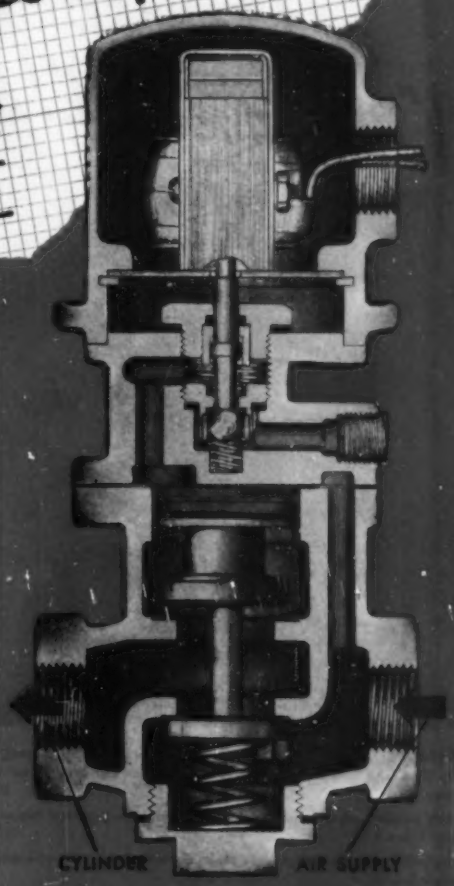

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- Low First Cost
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THE BRIDLE FOR AIR HORSEPOWER

ROSS OPERATING VALVE CO.

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NUTONE and REVERE "RING the BELL"!
NuTone "Symphonic" Eight-Note Westminster Door Chime. Walnut finish cover and brass chime tubes.

NUTONE'S Symphonic Door Chime, made by NuTone Incorporated, Cincinnati 27, Ohio. The company has recently added to its line Westminster Chime and Strike Clocks.

EASY polishing on centerless polishing machines is an important feature of Revere Brass Tubes.

POLISHED tubes are dipped in clear synthetic finish and up-ended to drain before baking.

• In the early days of NuTone, when the company was laying the foundation for a business that became the world's largest producer of door chimes, an important decision had to be made. A metal had to be selected for the chimes, one that would produce a soft, pleasant, resonant tone; a metal that was hard and durable; that would polish easily and retain a gleaming, luxurious surface for many years.

NuTone experimented with different metals, tested various products. Finally a Revere Brass Tube was selected, which was not surprising, because Revere itself had conducted extensive laboratory investigations into the factors responsible for pleasing tone. For the past 14 years, throughout NuTone's history, Revere Brass Tube has been used in increasing quantities. Revere has also collaborated in economy as well as quality, assisting on production problems, in the specification of multiple lengths to lessen scrap, and so on. This is a story of cooperation between two industries, and between a large company and one that used to be small, but is now the largest in its field . . . Revere is proud of the results of this long and happy association.

REVERE 150th YEAR OF SERVICE TO AMERICA

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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NUMBER 5

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Mallory Engineering Experience

Solves Power Supply Problem With Unique Vibrator Application

MALLORY VIBRATORS

Mallory Vibrators are based on exclusive design and manufacturing methods that assure long, trouble-free service. Send the details of your application. Get Mallory's recommendation on the Vibrator or Vibrapack* power supply best suited to your needs.

**Reg. U.S. Pat. Off.*

The versatility of the Mallory Vibrator and the practicality of Mallory engineering have been demonstrated in a growing variety of power supply applications.

One customer had been experimenting with germicidal lamps in produce trucks to retard bacterial action...but was stumped by the need for an efficient power supply. Mallory tackled the problem and came up with an ingenious application of the Mallory Vibrator . . . plus complete technical data for producing the complete power unit assembly.

That's service beyond the sale!

Mallory electronic know-how is at your disposal. What Mallory has done for others can be done for you!

Vibrators and Vibrapack* Power Supplies

P. R. MALLORY & CO. Inc.

MALLORY

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SERVING INDUSTRY WITH

Electromechanical Products
Resistors *Switches*
TV Tuners *Vibrators*

Electrochemical Products
Capacitors *Rectifiers*
Mercury Dry Batteries

Metallurgical Products
Contacts *Special Metals*
Welding Materials

Highlights

In this summary of technical developments, space restrictions do not allow giving complete details. Further information relating to any item can be obtained by writing to the Editor of Product Engineering.

METALLIC MATERIALS

HAFNIUM, with its high refractory properties, is now produced commercially. Financial backing from Air Force has accelerated development of an economical reduction technique.

THOUGH ANTIMONY IS SHORT, chromium and nickel are even shorter in supply. Attention is

therefore being given to using antimony electroplates for both protection and decoration on cars and appliances. Continuous non-porous antimony deposits are as corrosion resistant as the best Cu-Ni-Cr coatings of equal thickness; and their buffed surface more reflective than chromium.

MAGNESIUM ALLOY SHEET in widths up to 84 in. will be coming off a huge high-speed rolling mill. Dow Chemical Company expects to have the installation complete in eight to ten months.

VARIOUS APPLICATIONS are claimed for Chemilloy which is alloyed from virgin and reclaimed manganese bronze, pot metal and solder in a chemical carrier. Fine-grained, corrosion resistant and naturally glossy, the metal is suitable for bearings, precision castings, fluxless welding and as a heat dissipating medium.

PORCELAIN-COATED MILD STEEL is sharing some of the limelight as the Army Ordnance De-

partment. Application is in combat vehicle manifolds and mufflers where stainless steel is now used. If this substitution works out, the pinch on chromium and nickel will be somewhat eased.

SCREW-MACHINE OPERATIONS are becoming so rapid and precise that the machinability of the stock being cut is becoming ever more critical. As a result, interest in a lead-bearing steel called Ledloy, which has long been available but little used, is increasing. Compared to AISI B-1113 Bessemer sulfurized carbon steels, Ledloy machines 50 percent faster.

CONSIDERABLE DATA are now available on a series of Fe-Cr-Al alloys usable in place of Ni-Cr stock for electrical resistors and high-temperature applications. For compositions containing up to 10 percent aluminum and 30 percent chromium, single-phase materials have melting points from 2,750 to 2,870 F; volume resistivity at 20 C of 130 to 200 microhm-cm; and tensile strengths from 85,000 to 142,000 lb per sq inch.

NONMETALLIC MATERIALS

AIR-DRYING NEOPRENE can be sprayed or brushed on metal or wood to form a protective coating. Resistance to oil, grease and chemicals is said to be greater than that of oil-base paints.

PILOTS OF JET PLANES can sleep more soundly, now that new fire-wall seals are being in-

stalled. Sponge silicone rubber bonded to solid silicone sheet is sufficiently heat resistant to give the pilot time to bring an errant flame under control or bail out before heat becomes unbearable.

COLD-SETTING ADHESIVE mixed with aluminum oxide or French chalk hardens without shrinking to form a non-brittle surface coating that can be sanded to shape. Viscous liquid bonds well to aluminum and is therefore being used on airplane wing sections and bus bodies.

GASKETING MATERIAL made of synthetic rubber is especially effective in high-vacuum systems. Low vapor pressure of the soft, yet abrasion-resistant material, permits evacuation to one-millionth millimeter of mercury.

BALSA WOOD DUST works better than smoke when photographs of air-flow patterns are made. High reflectivity and low mass of balsa are the secret to this simple technique which has been used extensively in designing helicopter rotors.

CARDBOARD lined with nitrile-rubber-plasticized vinyl resin has proven satisfactory as

(continued on page 7)

IF YOUR PROBLEM IS

BEVEL GEAR OR CURVIC COUPLING DESIGN

MANUFACTURING EQUIPMENT

PRODUCTION TIME AND COSTS

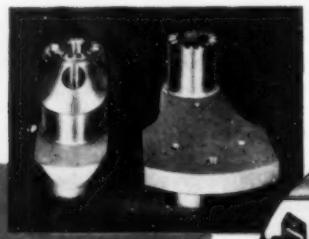
To help you . . .

THE DESIGN ENGINEER should provide us with preliminary layouts or prints of proposed bevel gear designs . . . type of drive, horsepower and speed . . . type of loading (constant, intermittent or shock) . . . type of material . . . driving member and direction of rotation.

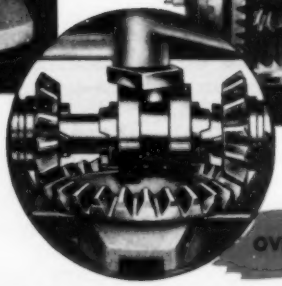
THE PRODUCTION ENGINEER should furnish blue prints, material specifications, manufacturing tolerances . . . quantity of gears to be produced . . . number of working hours available for production.

Every day highly skilled engineers within our organization provide the answers to these problems. Backed by the company's 85 years' experience in this field, our complete engineering service is at your disposal, without obligation, to study any bevel gear or Curvic coupling design problem you may have. We will be glad to make our recommendations as to the best design, the proper equipment and the most advantageous methods for reducing production time and costs.

SEMI-UNIVERSAL COUPLINGS



PERMANENT COUPLINGS



OVERLOAD CLUTCHES

BUILDERS OF BEVEL GEAR MACHINERY FOR OVER EIGHTY-FIVE YEARS — GLEASON

GLEASON WORKS

1000 UNIVERSITY AVENUE - ROCHESTER 3, NEW YORK

containers for motor oil and other petroleum products. This metal substitute may also be handy in the food packaging field because no ester-type plasticizer, a source of toxicity, is involved.

VEGETABLE MATTER such as corn sugar is one source for a new synthetic rubber recently developed by the Department of Agriculture in the Philadelphia labs. Claimed to have properties superior to natural rubber and other synthetics, material is a mixture of acrylonitrile and an acrylate.

PROCESSES

INSTRUMENT PARTS requiring a chemically inert, yet decorative and easily cleaned finish are now being die cast instead of sand cast or stamped, and then enameled. Zinc-base and copper-bearing aluminum alloys are first coated with phosphate, then covered with a synthetic enamel and baked. Copper-free aluminum is anodized and dyed black before enameling.

BUFF FINISHING of die cast parts is a simple matter if attention is given to certain details of design. Steps and channels should be avoided; framing ribs for nameplates should be as shallow as possible and permit buffing parallel to the ribs; and cored holes should have a radius to prevent smearing on one side and abrading on the other.

HOT FORMING after oil emersion of high-strength aluminum alloy aircraft parts works out better than when parts are cold-formed and then heat treated. For best results, both work and tools must be maintained close to 300 F. Springback is about 35 percent.

THE PROBLEMS of distortion and oxidation generally encountered when soldering 2S aluminum alloy with an iron or torch can be avoided if parts are induction heated. One successful application is an aluminum nameplate to which two threaded brass studs are attached. Parts, plus solder squares, are jigged and then the coil heating unit placed around the assembly.

ELECTROLUMINESCENCE may some day give the incondescent or gas-discharge light a run for its money. When certain materials are placed in a fluctuating electric field, light is emitted. A film of phosphor dispersed in a dielectric between two conducting plates is one approach.

INTERGRANULAR CORROSION around arc-welded areas in stainless steel is usually prevented by adding columbium. Now that this metal is in short supply, extra low carbon steel such as type 304, plus similar 308 ELC electrodes are being used to obtain corrosion-free weldments. Titanium could be used, but this is short too.

DEEP DRAWN 2S, 3S and 52S aluminum parts in runs up to 300 are economical when made with cast Kirksite dies and cast iron punches in a press equipped with hydraulic blank holder and die cushion. Replaceable metal inserts permit formation of symmetrical bulges. Steel shims of thickness equal to that of stock prevent wrinkling.

BONDING hard rubber to metal is a good trick. One method that works is to treat the rubber with concentrated sulphuric acid to "craze" its surface. Both rubber and metal surfaces are thoroughly cleaned, then coated with a Redux liquid adhesive and finally baked at 140 C for 20 min under pressure of 50 psi. Procedure can also be used for bonding metal and plastics.

COMPONENTS

INSIDE-OUT DRY CELLS have considerable promise, especially when it comes to the conservation of zinc. New design has a zinc center electrode and a compacted carbon outer shell. More of the active chemicals can be packed into the shell, resulting in a more powerful battery.

QUICK-RELEASE MECHANISM designed for jettisoning airborne equipment consists of two pivoted toggles that lock into load member when spread. Lifting of release arm unlocks toggles which deflect downward under weight of load, permitting load member to be pulled free. Release can be operated remotely through solenoids.

FOG LUBRICATOR atomizes oil into particles two microns in diameter. Several advantages result: A fog that remains in suspension for extended periods over relatively long distances; uniform particle distribution; thorough lubrication of surfaces between close-fitting parts; low airflow.

ALL WEARING PARTS of a combination clutch and brake unit used with medium and heavy machinery can be serviced while the assembly is in

(continued on page 9)

Another new development using

B. F. Goodrich Chemical Company ***raw materials***

Hycar seal developed and made by Parker, Stearns & Co., Brooklyn, N. Y.
Photo courtesy of Republic Aviation Corp., Farmingdale, Long Island, N. Y.

safest seal

FOR A THUNDERJET

THAT'S the greenhouse of a Thunderjet, ready to slip into position. When it does it will stay sealed air-tight, even at supersonic speeds and high pressures.

You wouldn't know that the manufacturer had tried dozens of seals—all failures until Hycar was used for the job. These inflatable seals of various materials would crease and fold in the corners or pull out of the channel. Some became soft under high temperatures. Some "ballooned" into the cockpit.

All that happened before a Hycar OR-25 compound was used. The seal is a U-shaped tube with a short intake tube connected to the Thunderjet's compression pumps for fast inflation to lock the seal. The tensile strength of Hycar, its low compression set, its resistance to low and high temperatures, its oil resistance and aging make it the ideal rubber compound for the purpose.

Hycar OR-25 is just one of a wide range of highly useful rubber compounds. They've helped solve many "tough" problems, because they are so versatile. For Hycar has advantages that exactly meet many civilian *and* defense needs.

Hycar has outstanding resistance to oil, gas and many chemicals. It resists heat and cold, weather and wear, abrasion and more hard-to-meet conditions. It may be just what you need to improve or develop a product. Right now demand for Hycar exceeds supply. But we can supply experimental quantities for development work. For helpful information and technical service, please write Dept. HL-3, B. F. Goodrich Chemical Company, Rose Bldg., Cleveland 15, Ohio. In Canada: Kitchener, Ontario. Cable address: Goodchemco.

B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

Hycar
American Rubber

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors

running position. Presses, power shovels and various types of rolling mill are applications.

FLAT-WIRE PREFORMS in continuous coil form simplify silver alloy brazing operations and insure a completely filled joint. Coil is notched longitudinally throughout its length so that as many as 550 rings per hour can be broken off the end of the coil and positioned ready for brazing.

POWER-METAL GEARS of the spur, miter and helical types are available in various thicknesses with diametral pitches ranging from 16 to 45 and pitch diameters from 0.333 to 2.682 inches.

ELECTRIC TACHOMETER that drives off the distributor of 6-v spark ignition engines has no relays, oscillators, gears or flexible shafts. Variations of the device include a vacuum gage and/or a revolution counter in addition to the tachometer which has a max scale reading of 4,500 revolutions per minute.

TESTING

ELECTRON HAMMER for displacing atoms in metal specimens is the latest addition to the list of atom smashers. This so-called statitron hauls particles up an "electrical hill" on a 3,000-fpm belt to a dome at the top of an accelerating tube. Released by a hot filament, a two-million-volt charge of electrons is accelerated down the tube against the specimen. Tube is in an 1,800 lb 40-in.-dia tank filled with dry nitrogen at 200 psi.

X-RAY CAMERA has platinum-rhodium wound work surface permitting use of the instrument at temperatures up to 1,500 C. Water-cooled body can be evacuated or filled with inert gases and film replaced or specimen moved without disturbing test conditions. Front slit is adjustable for widths from 0.2 to 1.0 millimeter.

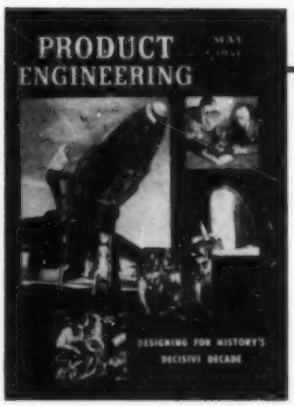
SELF-CONTAINED METER records vibrations and stresses up to 50 kc. Four separate traces are shown on a single 5-in. oscilloscope tube with each trace in its proper time relationship.

SKY'S THE LIMIT when it comes to counting atomic particles. By boosting the tube voltage of existing scintillation counters from 1,000 to 4,000 v, the passage of an atomic particle through suitable crystals or liquids can be indicated in a billionth of a second by the flash of a fluorescent light.

DYNAMOMETER ACCURACY has been improved through use of special cradle bearings and a hydraulic weighing system. Used for making power checks at the GM Research Labs, machine has two semi-circular pressure-lubricated pads that support the cradle. Hydraulic system measures engine torque by fluid pressure instead of weights and springs, thus reducing parts wear.

THREE-DIMENSIONAL PHOTOS will be coming out of commercial cameras as soon as a special lens and filter equipment are installed. Standard illustration and portrait cameras are easily modified to incorporate a lenticular plastic screen in the film or plate holder.

ANY COLOR can be picked out of a spectrum and projected via various optical elements onto a disk in a viewing chamber. One or two colors appear on a 3-in. disk within the chamber.



THIS MONTH'S COVER

Nose view of Navy's F-7U jet fighter, one of the newest and most powerful shipboard fighter planes in existence. Now in production at Chance-Vought, the plane is officially rated at "over 500 mph, is powered by two Westinghouse axial flow gas turbines. The F-7U typifies this issue, because all of the country's know-how on mechanical parts such as bearings, fabrication and machining of metal, testing and assembly, and on other design and production techniques is required to produce it. On the advancements in all fields of design engineering, as summarized herein, depends the future of more effective equipment for both peace and war.

Know Your Plastics

IT MAY MEAN BETTER AND FASTER PRODUCTION... AT LOWER COST

BAKELITE thermosetting Polyester Resins are combinations of styrene monomer and complex polyesters developed for contact pressure and low pressure molding, laminating, and casting. Polymerization is brought about by the use of catalysts, application of heat, or both. The resins are supplied as pale liquids in varying viscosities. They are produced in several grades, principal among which are detailed below.

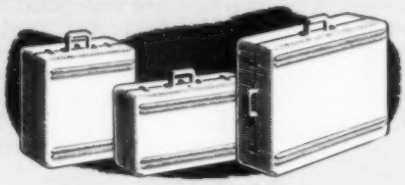
This message deals with "BAKELITE" POLYESTER RESINS

"BAKELITE" QRS-81 GENERAL PURPOSE

This general-purpose, liquid resin was developed for structural applications. It is particularly serviceable for matched-die molding because of its excellent moldability and easy flowing quality. Also readily formed with plaster, wood, and sheet-metal molds. Applicable to rubber-bag molding. Cures at room or elevated temperatures with standard catalysts. Does not precure. Retains excellent mechanical strength and electrical values at operating temperatures under 150 deg. F.

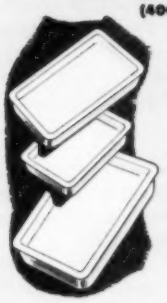
"BAKELITE" QRS-136 FLEXIBLE

This is a flexible resin sold as a non-plasticized liquid. It can be used alone for certain applications requiring a high order of toughness and flexibility, as in the production of tubing. However, it has been most useful to date as a modifier for other Polyester Resins to impart toughness and impact resistance in structural laminates and moldings. Compatible with most other Polyester Resins. Recommended for mechanical applications or where electrical insulating requirements are not critical.



"BAKELITE" QRS-17560 HIGH VISCOSITY

(4000-6000 cst.)

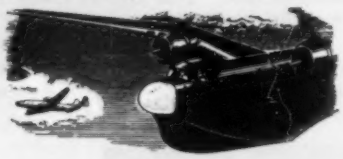


Formulated for producing castings or moldings with fewer inherent stresses and strains than with other grades of Polyester Resins. Provides non-crazing pieces of high resin content, with or without filler. Where fillers are called for, smaller quantities are required. Because of versatility of this resin it is particularly satisfactory for the production of castings made from glass-fiber preforms.

"BAKELITE" QRS-140 MEDIUM VISCOSITY

(300-600 cst.)

This is a medium viscosity resin developed especially to meet the insulating requirements for high-frequency electronic apparatus and components (9375 megacycles per second). In electrical properties it approaches BRS-16631, so widely used in World War II for radomes and other vital equipment. It is easier to handle than BRS-16631 because of improved moldability.



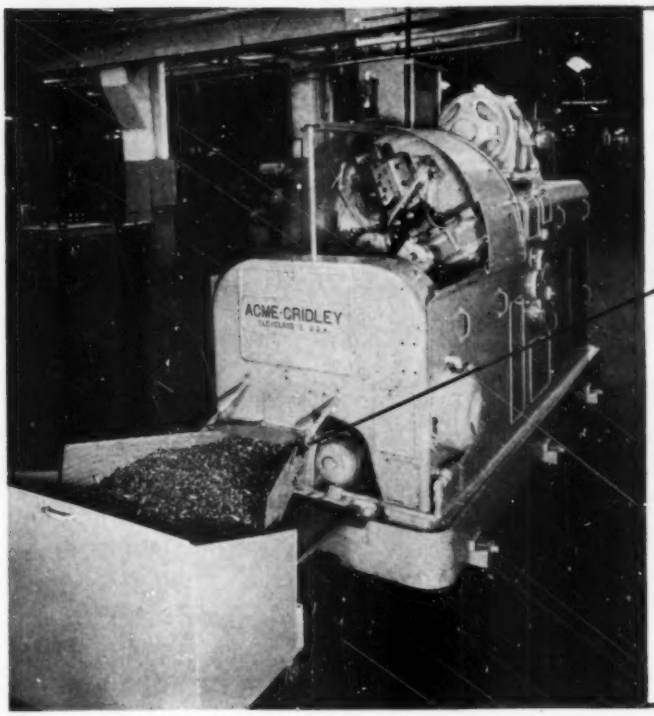
The development of BAKELITE Polyester Resins for molding reinforced plastics is a continuing operation of the Bakelite Laboratories. Formulations can be varied almost infinitely, and tailored to your particular jobs. Some of these jobs . . . chiefly with glass fiber cloth or mat . . . include boat hulls, radomes, refrigerator panels, housings, luggage, to which they give light weight, high impact, tensile, and flexural strength, and resistance to moisture, many chemicals, and heat. Superior electrical insulation values are attainable. For instance, laminates made with these resins have relatively low power factors throughout the 60 to 10^6 cycles range. They eliminate the need for costly molds, high heat, and high pressures. Engineers and designers interested in BAKELITE Polyester Resins are urged to outline their needs *in fullest detail* for a thorough, confidential analysis. Write Dept. BV-10.

BAKELITE
TRADE-MARK
POLYESTER RESINS

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

All Screw conveyors are not the same

LINK-BELT offers you the widest range to match your design needs



HELICOID CONVEYOR . . .

Trouble-free chip removal on this National-Acme high-speed automatic Model M Single Spindle Bar is provided by a Link-Belt Helicoid (Screw) Conveyor, shown above before assembly. The trough is tailor-made to fit the housing and hoppers of the screw machine, and the drive is located at the discharge end for convenience of inspection and lubrication.

Helicoid and Sectional Conveyor Screws, mounted or unmounted, are available for general applications; may also be furnished in the metal best suited to your purpose, in finishes varying from very dull to highly polished.

MORE than capacity . . . more than length . . . are considered by Link-Belt engineers when they recommend screw conveyor for your machines. Abrasiveness, moisture content, size of feed, corrosiveness and many other factors are vitally important.

Remember, Link-Belt is the nation's top producer of materials handling and power transmission equipment . . . another reason why Link-Belt Screw Conveyors are simple, compact, have few wearing parts, greater dependability. Then too . . . They're accurately made to insure easy assembly and smooth operation.

Link-Belt Screw Conveyors are made in both continuous and sectional flight types — mounted and unmounted. Our engineers will be glad to give you the complete story.

LINK-BELT

SCREW CONVEYORS

LINK-BELT COMPANY: Chicago 8, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities. 52.335

Positive snap action . . . for military and civilian applications

Klixon Thermo-Snap Controls . . . hermetically sealed and open types . . . give accurate temperature control. Actuated by the simple, snap-acting "Spencer Disc," their snap-action opens the circuit with a *quick, clean break* . . . closes the circuit to a *solid make*. Their accurate operation is best able to withstand shock, vibration, altitude or motion.

Klixon Thermo-Snap Controls are used in many military and commercial applications including use as — low limit and high limit controls, fuel delay switches, purge switches, temperature controls, fan switches, tube and rectifier cooling control, etc. . . . in products ranging from tanks and airplanes, sterilizers, radio and electronic equipment to household electric appliances, dairy heaters, etc.

They are available in many types and ratings including completely hermetically sealed units. Our engineers will gladly help you with your problems. Write for information today.

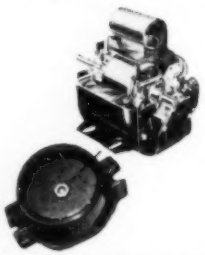
KLIXON

SPENCER THERMOSTAT

Division of Metals & Controls Corp.

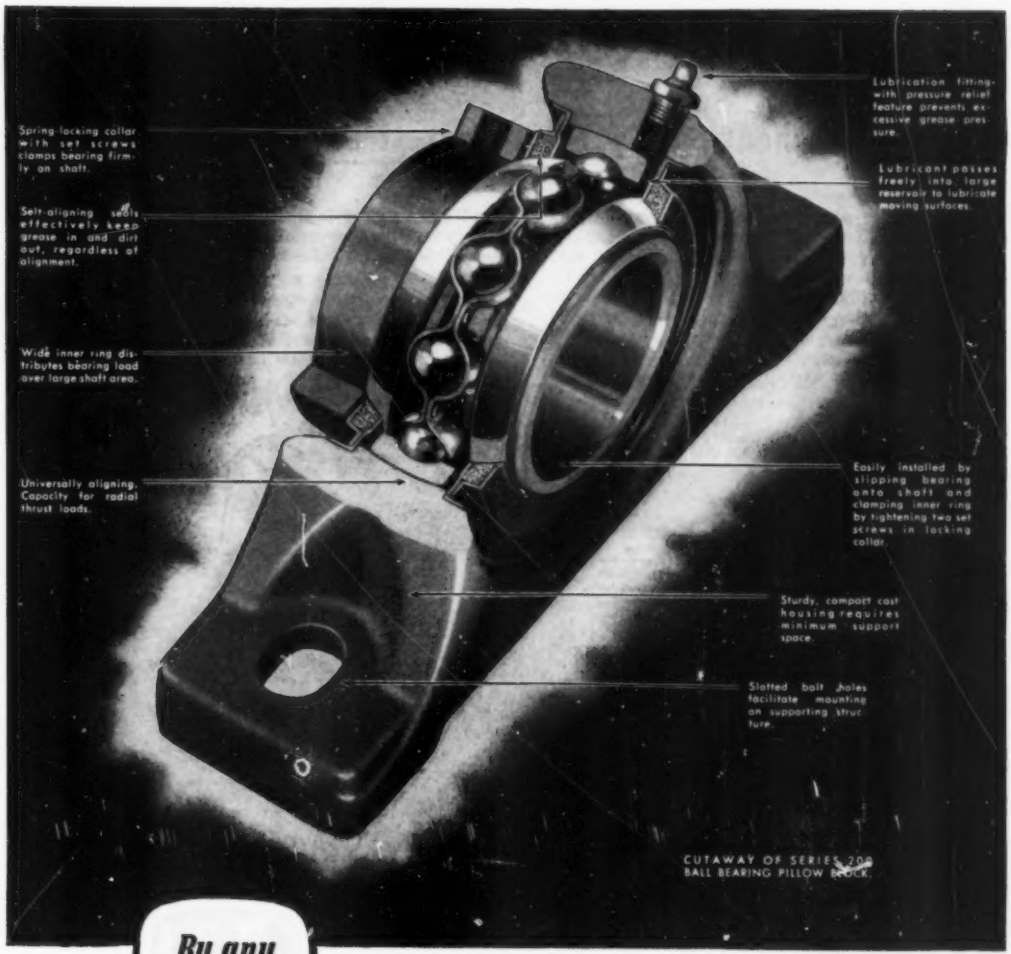
905 FOREST ST., ATTLEBORO, MASS.

KLIXON
MOTOR PROTECTORS
PREVENT MOTOR BURNOUTS



To keep motors operating longer specify and use motors with built-in Klixon Protectors. Should a motor become overheated, the Klixon Protector snaps the power "off," preventing a motor burnout. When it cools to safety, the protector snaps the power "on" automatically if the *automatic reset* is specified . . . or by pushing the red button when the *manual reset type* is used.

LINK-BELT Ball and Roller Bearings smooth the path of power


Spring-locking collar with set screws clamps bearing firmly on shaft.
Self-aligning seals effectively keep grease in and dirt out, regardless of alignment.
Wide inner ring distributes bearing load over large shaft area.
Universally aligning. Capacity for radial thrust loads.
Lubrication fitting with pressure relief feature prevents excessive grease pressure.
Lubricant passes freely into large reservoir to lubricate moving surfaces.
Easily installed by slipping bearing onto shaft and clamping inner ring by tightening two set screws in locking collar.
Sturdy, compact cast housing requires minimum support space.
Slotted bolt holes facilitate mounting on supporting structure.
CUTAWAY OF SERIES 200 BALL BEARING PILLOW BLOCK.

By any standard . . . **LINK-BELT Bearing Blocks protect and lubricate all moving surfaces**

To give you longer bearing life and extended lubricating schedules, Link-Belt Ball and Roller Bearings are Housing-Sealed — all moving surfaces are completely enclosed and centrally lubricated from a large common reservoir. And only from Link-Belt do you get this important advantage on ball as well as roller bearings. There's a Link-Belt Bearing Specialist near you. Or you can get full engineering information in Data Book 2550.

10,283

LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in principal cities.

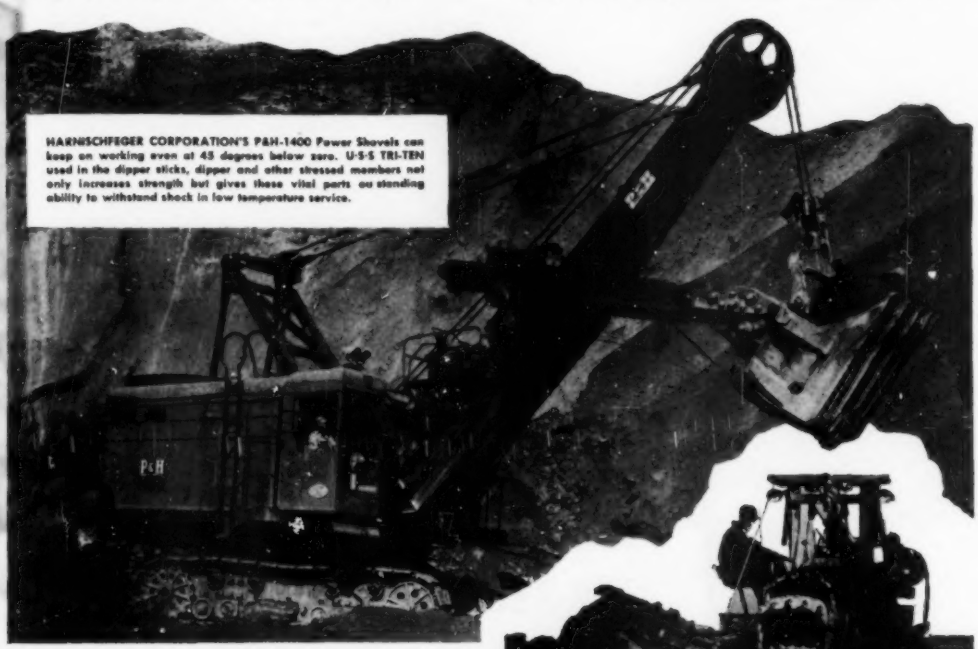
Give it the stamina

Build your heavy-duty equipment stronger, tougher and

Here's a report from the Harnischfeger Corporation, makers of the famous P & H Power Shovels, that shows how these tougher, stronger "*steels that do more*" will keep equipment working under conditions that ordinarily play hob with operations. Every designer, every materials engineer and every contractor who has been plagued with part breakage during cold spells will appreciate its importance.

Says Harnischfeger: "We have used U·S·S TRI-TEN principally in our power shovel products. The continual trend to increased loading capacities together with more severe field service has greatly accelerated the use of this type of U·S·S High Strength Steel.

"Generally speaking, we have found that by replacing ordinary structural steel with TRI-TEN, the weight of our component parts has been reduced 25%. Allowable working stresses have been increased 50%—from 16,000 to 24,000 psi. What's more, TRI-TEN has enabled our P&H-1400 power shovel customers to operate this equipment in temperatures as low as minus 45° F."



HARNISCHFEGER CORPORATION'S P&H-1400 Power Shovels can keep on working even at 45 degrees below zero. U·S·S TRI-TEN used in the dipper sticks, dipper and other stressed members not only increases strength but gives these vital parts an standing ability to withstand shock in low temperature service.

THE CLEVELAND TRENCHER COMPANY has this to say about U·S·S MAN-TEN: "Much of the success of Cleveland Trenchers is due to the use of MAN-TEN. Used 100% in the wheel rims and buckets, MAN-TEN imparts greater strength and greater toughness to these digging elements—enables us to produce a rugged machine that will tear into sharp sand, hard clay, sandstone formations, shale, adobe and gumbo at a high rate of speed.

"By using MAN-TEN in frame and structurals, also, we are able to keep down the over-all weight, to increase mobility and to step-up ruggedness and dependability. These are important factors in a machine like this that must operate in all kinds of weather and often in the most remote locations."

USS

U·S·S HIGH STRENGTH STEELS

UNITED STATES STEEL

to stay on the job...

more durable with these U·S·S High Strength Steels

Now—when equipment is being called upon to deliver the utmost in performance—*dependability* becomes of prime importance, so bear these facts in mind:

- **Whenever your design requires that the steel must have high yield point, high tensile strength, good corrosion resistance and ability to stand up at normal and sub-zero temperatures . . .**
- **When parts must possess a high strength-to-weight ratio, must resist abrasion and have high resistance to fatigue failure . . .**
- **When the steel must, in addition, lend itself readily to fabrication and machining . . .**
- **You can satisfy all these requirements, without adversely affecting the cost of your product, by building with U·S·S High Strength Steels.**

U·S·S TRI-TEN, U·S·S COR-TEN and U·S·S MAN-TEN are neither new nor untried. In literally hundreds of thousands of applications they have proved their ability to keep equipment on the job—to minimize down-time and maintenance costs—by increasing the strength, ruggedness and durability of parts subjected to unusual stresses or destructive conditions.

Our engineers and metallurgists have had 15 years' experience applying U·S·S High Strength Steels to all kinds of equipment. Let them show you how these tougher, stronger steels can be applied to your product to make it more efficient and dependable.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND
COLUMBIA STEEL COMPANY, SAN FRANCISCO
NATIONAL TUBE COMPANY, PITTSBURGH
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
UNITED STATES STEEL COMPANY, PITTSBURGH
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S TRI-TEN

This manganese-nickel-copper steel has a yield point of 50,000 psi min. and a tensile strength of 70,000 psi min. in thicknesses ½" and under, with moderately lower values as thickness increases to a maximum of 4". It has superior toughness and ability to withstand shock at sub-zero temperatures. It has greater resistance to abrasion than structural carbon steel (ASTM A7) and its fatigue resistance is 50% higher. U·S·S TRI-TEN'S resistance to atmospheric corrosion is slightly superior to copper steel.

Because U·S·S TRI-TEN has very good welding properties in intermediate and heavier thicknesses, this grade of U·S·S High Strength Steel is particularly recommended for application in heavy duty equipment where maximum ruggedness and strength with minimum weight are prime requisites. U·S·S TRI-TEN is produced in plates, structural shapes, bars and bar shapes.

U·S·S COR-TEN

U·S·S COR-TEN is a ductile, low-carbon chromium-nickel-silicon-copper-phosphorus steel having a yield point of 50,000 psi min., and a tensile strength of 70,000 psi min. in thicknesses ½" and under.

Its resistance to abrasion and shock is superior to structural carbon steel; its fatigue resistance—that is, its ability to withstand repeated stresses—is 60% greater.

What particularly distinguishes U·S·S COR-TEN is its unusually high resistance to atmospheric corrosion—4 to 6 times that of plain steel, 2 to 3 times that of copper steel. This property helps to assure the long life and low maintenance cost of any equipment in which COR-TEN is used, whether to obtain greater durability or to reduce weight.

U·S·S COR-TEN is produced in all standard products—plates, shapes, bars, sheets, strip, special cold formed sections, wire and tubular products. Recommended particularly in light and intermediate thicknesses.

U·S·S MAN-TEN

U·S·S MAN-TEN is a grade of manganese-copper steel that, at relatively low cost, provides toughness, workability and weldability in a higher degree than obtainable in carbon steel of the same strength level. Its atmospheric corrosion resistance is slightly higher than that of copper steel.

U·S·S MAN-TEN, in thicknesses up to ½" inclusive, has a yield point of 50,000 psi min. and tensile strength of 75,000 psi min. Its abrasion resistance is greater than that of structural carbon steel (ASTM A7); its resistance to sudden shock is about 20% greater; its fatigue strength is approximately 40% higher, insuring greater ability to withstand vibration and reversal of stresses.

U·S·S MAN-TEN is produced in plates, shapes, bars, sheets, strip, special cold-formed sections and other forms. It is particularly recommended for use in light and intermediate thicknesses.

LaPLANT-CHOATE give three good reasons for using U·S·S COR-TEN in their high speed Moto-Scraper: "Increased endurance limit. The life of several parts of this machine is governed by the fatigue limit of the steel. You will readily understand what the use of high strength steel as against mild steel means in this respect."

"These machines often self-load large boulders, etc. and the resistance to impact of high strength steel we have found is far superior to mild steel."

"High strength steel polishes considerably more than mild steel with this type of use our machine is subjected to. This enhances the loadability as well as the unloading of the machine."

Simple Drive or Complex Transmission

WHITNEY

CHAIN DRIVES

Provide Positive Power—Long Life!

Whitney Chain Drives provide innumerable opportunities to save time and money by simplifying drive design.

If your power transmission problems involve long or short centers, reversal of direction, timing motions, fractional or hundreds of horsepower, the unusual adaptability of Whitney Chain Drives will help you meet your design requirements efficiently and economically.

Besides meeting your designs, Whitney Chain Drives help to make a good product better. Their positive grip assures efficient power transmission . . . means that you get *full rated Horsepower* from driver to driven elements. They reduce costly down time — are easy to install, easy to remove without disconnecting shafts or bearings. Their rugged construction of hardened alloy steel parts assures long service with minimum maintenance . . . a vital point in these days of all-out production.

From the complete line of Roller, Silent and Conveyor Chain Drives, Whitney engineers can recommend, without bias, the proper type of drive for each application . . . the chain drive which will give you the best service at lowest cost.

Consult your local Whitney Field Office or Distributor, or write direct to us for complete information and catalog.

WHITNEY CHAIN COMPANY 204 HAMILTON STREET, HARTFORD 7, CONNECTICUT

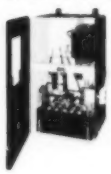
use one of these 6 Reduced Voltage Starters

To prevent damage to many machines or to materials in process, squirrel cage motors often need gradual acceleration. For such applications, one of these reduced voltage starters will provide the desired speed-torque control.

This line of A-B starters is extremely versatile, providing either manual or automatic starting . . . with 2 or 3 step acceleration . . . or stepless control up to full speed . . . to fit the most critical motor starting requirement.

MANUAL—TRANSFORMER TYPE

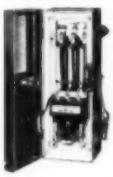
Manual transformer type starter up to 125 hp, 220 v; 250 hp, 600 v max. Air break or oil immersed contacts. Automatic reset overload relays. Time delay mechanism determines proper time interval for manual switch-over of hand lever.



BULLETIN 646

MANUAL—COMPRESSION TYPE

Manual compression resistance starter up to 50 hp, 220-600 v max. Graphite discs in the insulated tubes are compressed with the hand lever for stepless speed control. Ideal starters for chain or belt drives. Overload relay protection.



BULLETIN 640

AUTOMATIC—3 STEP RESISTANCE

Automatic resistance starter up to 400 hp, 220-600 v max. Accelerates squirrel cage motors in 3 steps. Resistors easily adjusted for ideal starting of motors on power networks. For more than 3-point control, use Bulletin 742 starter, below.

BULLETIN 741

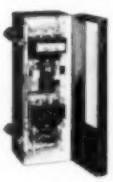
AUTOMATIC—TRANSFORMER TYPE

Automatic reduced voltage starter up to 300 hp, 600 v max. An accurate timing relay controls the accelerating time. Operator touches start button—the starter does the rest. Available in standard, watertight, and dust-tight enclosures.

BULLETIN 746

AUTOMATIC—2 STEP COMPRESSION

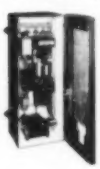
Automatic resistance starter with preset adjustable graphite resistors up to 250 hp, 220-600 v max. Push button closes starting circuit through resistors. Later, timing relay closes running contactor and cuts out the starting resistors.



BULLETIN 740

AUTOMATIC—STEPLESS TYPE

Fully automatic resistance starter with solenoid controlled graphite disc resistors rated up to 500 hp, 220-600 v max. Stepless control of current and speed. Acceleration adjustable to avoid lamp flicker. Overload relay protection.



BULLETIN 742

Write for Bulletins to Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin

A-B Quality

ALLEN-BRADLEY

REDUCED VOLTAGE STARTERS

QUALITY

351-MR

for VELVET SMOOTH ACCELERATION

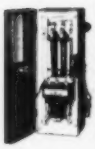
use these Allen-Bradley Starters with Graphite Compression Resistors

Cutaway view of Allen-Bradley graphite resistor tube showing discs, insulating lining, and the pressure terminal.

With these Allen-Bradley compression resistance starters you can start squirrel cage motors with such velvet smoothness that there is no voltage dip . . . no lamp flicker. The secret of this stepless acceleration lies in the smooth control of the Allen-Bradley graphite compression resistors which are shown below.

BULLETIN 640 MANUAL
Stepless Resistance Starter

The motor current passes through the graphite disc resistors. Compressing them with the hand lever reduces the starting resistance steplessly until it is shunted automatically by the running contactor.



Bulletin 640 manual starters have a hand lever for manually compressing the resistors. At maximum speed position, a magnetic contactor automatically connects the motor to full voltage.

BULLETINS 740 & 741 AUTOMATIC
2 and 3 Step Resistance Starters

In these two resistance starters the adjustable resistors are arranged in 2 or 3 steps. Each step is cut out, successively, by timing relays. These starters can be easily adjusted for equal current inrush per step.

Bulletin 740-741 starters are rugged, automatic starters.

BULLETIN 742 AUTOMATIC
Stepless Resistance Starter

In this starter, compression of the graphite discs is done automatically by a solenoid mechanism. Absolutely velvet smooth acceleration is obtained. No other starters provide similar stepless control.

Bulletin 742 resistance starters prevent lamp flicker on network systems. They provide automatic stepless starting for machines and processes which are easily damaged by sudden starting.

BULLETIN 646 TRANSFORMER TYPE STARTER

For loads with high starting friction, requiring sudden applications of power, use the Bulletin 646 manual or the Bulletin 746 automatic transformer type starters.

Write for Bulletins to Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin

ALLEN-BRADLEY
REDUCED VOLTAGE STARTERS
QUALITY

A-B Quality

351-MR

Have you a Military Job for this Special Counting Mechanism?

. . . then you will find out what we mean when we say . . .

Everyone Can Count on VEEDER-ROOT

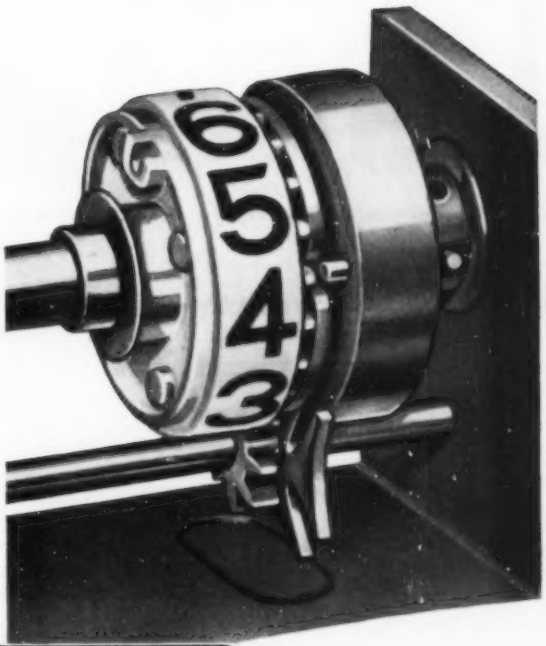
You're looking at a new *and patented* development . . . featuring the Veeder-Root "Geneva Transfer" . . . designed for higher speeds and easier readability from a distance.

Here's another vitally important Veeder-Root "first," for use in military equipment. And within the understood limitations of the present-day rule of "first things first" . . . what can we *figure out* for you?

VEEDER-ROOT INC.

HARTFORD 2, CONN. • GREENVILLE, S. C.
Montreal, Canada — Dundee, Scotland

Offices and agents in principal cities



VEEDER-ROOT COUNTERS *"Count Everything on Earth"*

CHOOSE BLACKHAWK
for your product

Electric *Power-Packer*

Here's the *dependable* answer for electrically-operated hydraulic control of implements and attachments. Uses a 6-volt standard automotive starter-motor for power.

Speed—Lifts the load three times faster than hand-operated pumps.

Remarkable Efficiency means low battery drain. Tests show ordinary 6-volt auto battery (without rest or charging) still operating after 150 average lifts.

Positive Displacement means no slippage under varying temperature and load conditions.

Control is simple, *precise!* It lifts and lowers at any desired speed — and holds the load, too.

Quiet, Smooth Operation— no peak loads on the battery — thanks to the balanced 4-piston wobble-plate pump.

Simple Installation —It is a complete package — pump, reservoir, valve and electric head. Only four mounting holes. Port is ¾" N.P.T. for use with Blackhawk equipment hose.

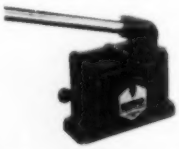
SPECIFICATIONS

MODEL	P-247	P-248
Normal Operating Pressure (P.S.I.)	5000	2500
Maximum Intermittent Pressure (P.S.I.)	10,000	5000
Reservoir Capacity (Closed Reservoir)	105 cu. in.	105 cu. in.
Reservoir Capacity (Vented Reservoir)	166 cu. in.	166 cu. in.

For use with 6 volt D. C. Systems.

P-248 delivers 70 cu. in. of oil per minute at 2500 p.s.i. with power drain of 660 watts; or, another example, it delivers 50 cu. in. of oil per minute at 5000 p.s.i. with power drain of 815 watts. Weight 58 lbs. 8 oz.

(Electric pump-head is available as separate unit for converting P-60 and P-63 Power-Packers from *hand-operation* to electrical operation in the field. It's *easy* because reservoirs of hand-operated and electrically-operated units are identical.)



Hand-Operated *Power-Packer*
(Double-Acting)

Specified as "standard" by hundreds of equipment manufacturers. No other hand-operated pump equals its sales records.

SPECIFICATIONS

MODEL	P-60	P-63
Maximum Pressure (P.S.I.)	5000	2500
Displacement per stroke (Cu. In.)	.294	.557
Diameter of Pump Pistons	½"	11/16"
Reservoir Capacity (Cu. In.)	114 cu. in. closed 231 cu. in. vented	114 cu. in. closed 231 cu. in. vented

Weight 30 lbs. Has ¼" N.P.T. Port. Also available without reservoir for integral mounting.

Hand-Operated *Power-Packer, Jr.*
(Single-Acting)

The low cost of this refined, compact pump series permits hydraulics on a broadened range of equipment.

SPECIFICATIONS

MODEL	P-146	P-147	P-148
Maximum Operating Pressure (P.S.I.)	6000	5000	2500
Displacement per Stroke	.15033	.19635	.37122
Diameter of Pump Piston	7/16"	½"	11/16"
Handle Effort at Maximum Pressure	57 lbs.	61 lbs.	58 lbs.
Reservoir Capacity	45 cu. in. when closed		

Weight 14 lbs. 7 oz. Has ⅜" N.P.T. port bushed to ¼" N.P.T.

Power-Driven *Power-Packer*

Pump, valve and reservoir are in *one package* . . . eliminating expensive piping and installation problems. The pump has the same characteristics found in the popular P-104 Pump (opposite page).

SPECIFICATIONS

MODEL	P-219	P-220
Capacity of G.P.M. at 900 rpm	1.375	1.375
Maximum Intermittent Pressure (P.S.I.)	4000	4000
Normal Operating Pressure (P.S.I.)	2500	2500
Recommend Speed Range (rpm)	600-1200	600-1200
Reservoir Capacity (closed)	1 gal.	½ gal.
Reservoir Capacity (vented)	2 gal.	1 gal.
Weight	70 lbs.	52½ lbs.
⅜" N.P.T. port.		

See Sweet's Product Designer's File

YOU ARE INVITED TO WRITE FOR FULL FACTS — mentioning Blackhawk components in which you are specifically interested. Engineering counsel willingly furnished—in confidence. Blackhawk Mfg. Co., P. O. Box 613, Milwaukee 1, Wis.

HYDRAULIC CONTROLS

Scores of critical designers and buyers recognize that *Blackhawk* hydraulics create exclusive advantages for the engineering, manufacturing, sale and service of their products. Blackhawk has specialized in this field for over 25 years.

15 H.P. 6-PISTON WOBBLE-PLATE POWER-DRIVEN PUMP

This modern pump — *No. P-237* — offers over-all efficiencies above 90% — with no premium in price. Positive displacement makes a wide range of pressures and speeds practical. Delivers 3 G.P.M. at 1350 R.P.M. and 6000 P.S.I. with only 11.65 H.P. input. Following are characteristics at maximum recommended speed and pressure for intermittent service.

Speed R.P.M.	G.P.M.	Pressure	H.P.
2200	4.7	4800 P.S.I.	15
1750	3.9	6000 P.S.I.	15

Weight — 40 lbs.

5 H.P. TWIN-PISTON POWER-DRIVEN PUMP

The positive-displacement P-104 pump is famous for the amazing performance it achieves with its low-cost design. Practical for pressures up to 4000 P.S.I. in intermittent operation. At 900 R.P.M. it delivers 1.375 G.P.M. at 4000 P.S.I. with 5 H.P. input.

SPECIFICATIONS

Recommended maximum pressures — 4000 P.S.I. for intermittent use . . . 2500 P.S.I. for continuous use.

Capacity (at 900 R.P.M.), 1.375 G.P.M.

Speed (at maximum pressure) — minimum, 600 R.P.M.—Recommended, 900 R.P.M. — Maximum, 1200 R.P.M. (Maximum speed can be exceeded with *reduced* pressure).

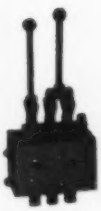
The integral safety valve is normally set 500 P.S.I. above working pressure.

Over-all dimensions: 5¾" x 7⅛" x 7¼" (including shaft) — Weight: 18 lbs. 4 oz.

RAMS

Blackhawk offers a long line of standardized single-acting rams. Exclusive, leakproof designs. Special single or double-acting rams are produced on quantity orders.

VALVES



"VALVBANK" POSITIVE-SEALING CONTROL SYSTEM

The V-28 valve is an open-center, series-type precision-control valve. Hydraulically balanced, it handles up to 6000 P.S.I. working pressures with finger-tip actuation. Flow capacity up to 6 G.P.M. A "Valvbank" can be made up in any combination of single and double-acting control units and includes a relief valve. It is spring-returned to the neutral "hold" position, providing "deadman control." All ports are ½" standard pipe thread.

SELECTOR-TYPE CONTROL VALVE

The V-66 precision control valve is for use up to 4000 P.S.I. and 2.5 G.P.M. Available in "bank" style like the V-28. Compact. Normally recommended for use with the P-104 power-driven pump. Handle remains in selected position until manually returned. Has ⅜" N.P.T. ports.

SINGLE-ACTING POSITIVE CONTROL VALVE

An open-center, spring-returned, single-acting control valve. Simple construction—low cost—rugged. The V-15 includes a cushioned lowering device which also allows connection of valves in series for multiple ram control. For light return loads, the V-16 affords less restriction in returning oil, but can be used in the control of only one ram — handling up to 2.5 G.P.M. maximum flow and 4000 P.S.I. operating pressure. All ports are ⅜" N.P.T. bushed to ¼" N.P.T. for use in system that has small volume. Weight —6 lbs. 12 oz.

AUXILIARY VALVES

Blackhawk Valves are also available for remote release and relief purposes, adjustable throttling, manual shut-off and safety pressure-release.

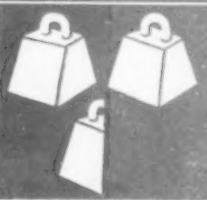
BLACKHAWK HYDRAULIC EQUIPPED

An Emblem Representing Dependability Throughout Industry

BLACKHAWK

Examples of Savings of Metals,

DIE CASTINGS

PART	WEIGHT AND METAL IN DIE CASTING	SAVING OF METAL OVER OTHER METHODS
ALUMINUM BOOSTER CUP		
ALUMINUM FUZE HEAD		
ALUMINUM FUZE BODY		
BRASS BOOSTER CASING		

In the present emergency, Doehler-Jarvis is ready with 100 per cent increase in capacity since World War II, with seven plants located strategically in the following cities:

TOLEDO, O.

POTTSTOWN, PA.

GRAND RAPIDS, MICH.

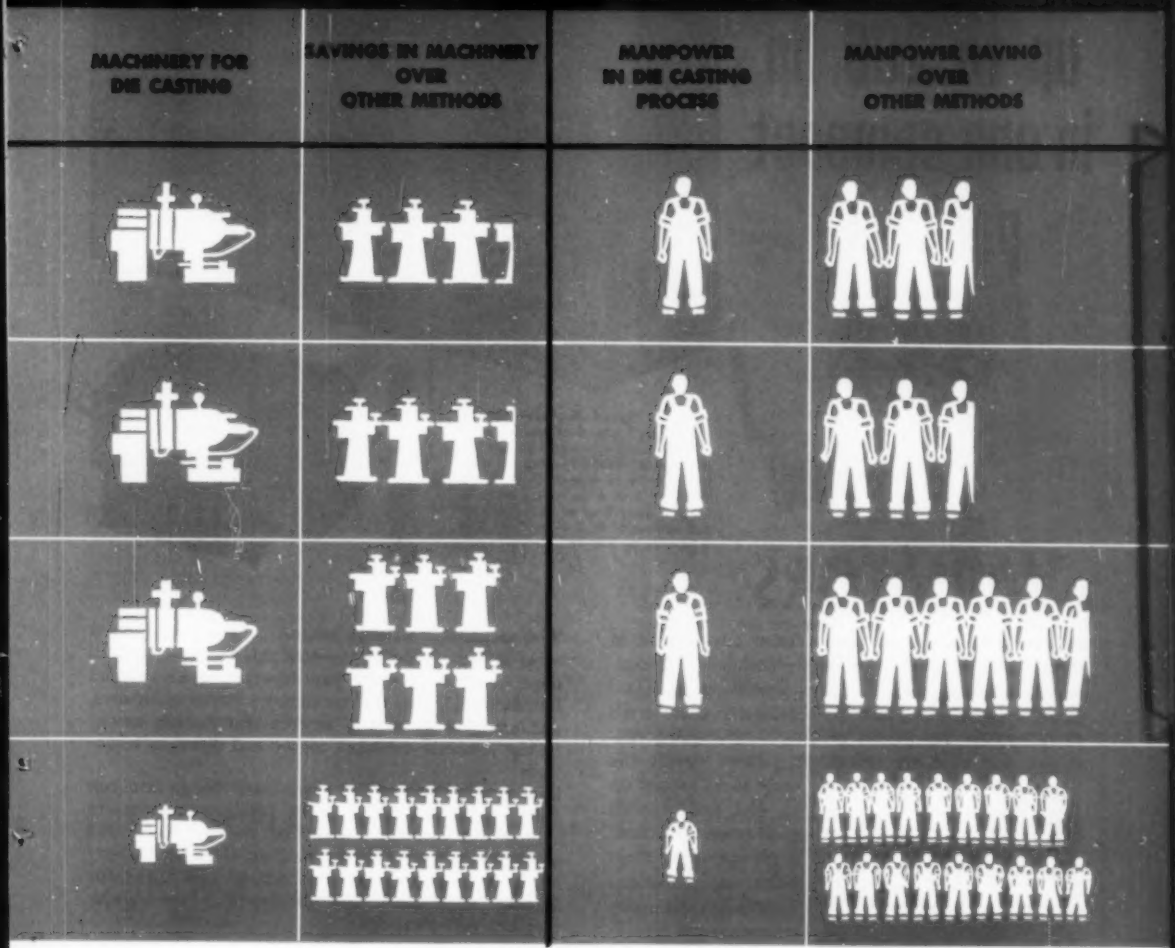
BATAVIA, N. Y.

CHICAGO, ILL.

Doehler-

Machines and Manpower by Using

in Armament Production


MACHINERY FOR DIE CASTING
SAVINGS IN MACHINERY OVER OTHER METHODS
MANPOWER IN DIE CASTING PROCESS
MANPOWER SAVING OVER OTHER METHODS

The World's Largest Producer and Finisher of Die Castings

Jarvis **CORPORATION**

Executive Offices, New York

DOEHLER-JARVIS

Designer's NOW up to 200 hp in one compact package!

New G-E Speed Variator power "package," typical of ratings 75 to 200 hp, comes in two units for greater plant-layout flexibility. M-g set cabinet (5 ft ⅛ in. high by 9 ft 9½ in. wide by 3 ft 4 in. deep) may be located away from or bolted to control cabinet (7 ft 6 in. high by 2 ft 6 in. wide by 3 ft 4 in. deep).

SPEED VARIATORS

All the advantages designers have appreciated in General Electric Speed Variators—packaged, pre-engineered adjustable-speed drives operating from a-c power systems—can now be obtained in units rated 75 to 200 hp. On punch presses, wire drawing machines, mill auxiliary drives, etc., they provide the same speed ranges up to 40:1 and beyond, good speed regulation, great operating flexibility, and minimum installation and maintenance cost.

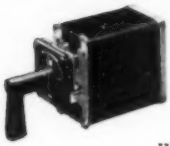
GENERAL ELECTRIC *Headquarters for* Electric ADJUSTABLE-SPEED DRIVES

With adjustable-voltage control in whatever type is most suited to the need—straight magnetic, amplidyne, or electronic—this new drive requires no special foundations, includes all necessary protective features, and contains all wiring between components except to the remotely-mounted motor and operator's controls.

Best of all, standardized component design lets you specify only the features you need, permits prices comparable to other drives that require costly field assembly. For more information on these new larger-hp Speed Variators, check your nearest G-E Apparatus Sales Office. Bulletin GEA-5335 describes Speed Variators in 1–60 hp ratings.

GENERAL ELECTRIC

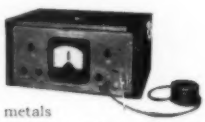
Digest — GE PRODUCT HIGHLIGHTS



VERSATILE SWITCH makes good 10,000 ways!

What's behind the success story of the General Electric Type SB-1 switch? Simply this: By varying its many *standard, interchangeable* cams, contacts, fingers and other parts, you can arrange for over 10,000 control and transfer combinations, use it for practically any control job on low-capacity circuits. For extra-heavy duty, there's the tougher Type SB-9, with the same features plus extra wear-resistance. Both types mount on ⅛- to 2-inch-thick panels, are rated up to 20 amperes at 600 volts a-c or d-c. See Bulletins GEA-4746 (SB-1) and GEA-4114 (SB-9).

METALS COMPARATOR cuts scrap losses economically!



With both ferrous and non-ferrous metals now in tight supply, you'll need the material savings a General Electric metals comparator can bring you. It provides an economical, non-destructive test of metal parts for composition, heat treatment, hardness, or plating thickness—decreases scrap losses due to mixed material or incorrect processing. Parts are quickly compared against a reference standard. Uses single-phase, 60-cycle, 110-volt supply. See Bulletin GEC-566.

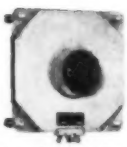
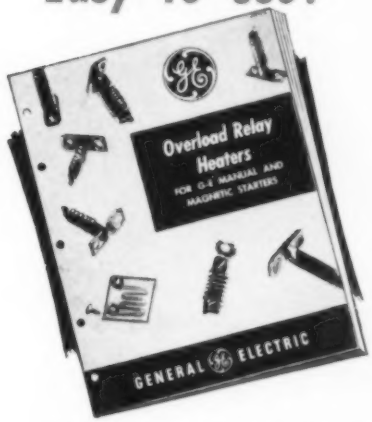


PLATE-TYPE RHEOSTAT gives accurate speed control!

Specify these General Electric plate-type field rheostats for mounting on a machine tool, switchboard, or control or operator's panel, and you've provided for speed control of d-c motors, or voltage control of generators and exciters. The 6-, 9-, and 12-inch standard sizes contain 27, 52, and 70 resistance steps for accurate adjustment. Adjustable stops at each end of travel save time, assure uniform operation, are easily reset for added flexibility. See Bulletin GEC-487.

New! Complete! Easy to use!



LISTS RELAY-HEATER RATINGS FOR G-E MOTOR STARTERS

Just out is this handy guide to the selection of overload relay heaters for most types and sizes of General Electric manual and magnetic starters. In one convenient 16-page reference booklet, it concentrates data from many sources, makes it easier and faster for you to match heaters to motors. Check Bulletin GEC-127B in the coupon below.

General Electric Company, Sec. J668-88
Schenectady 5, New York

Please send me the following bulletins:

√ for reference purposes
X in connection with immediate projects

- ☐ GEA-4114 Type SB-9 switch
- ☐ GEA-4746 Type SB-1 switch
- ☐ GEA-5335 1-60 hp speed variator
- ☐ GEC-127 Relay-heater catalog
- ☐ GEC-487 Plate-type field rheostat
- ☐ GEC-566 Metals comparator

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

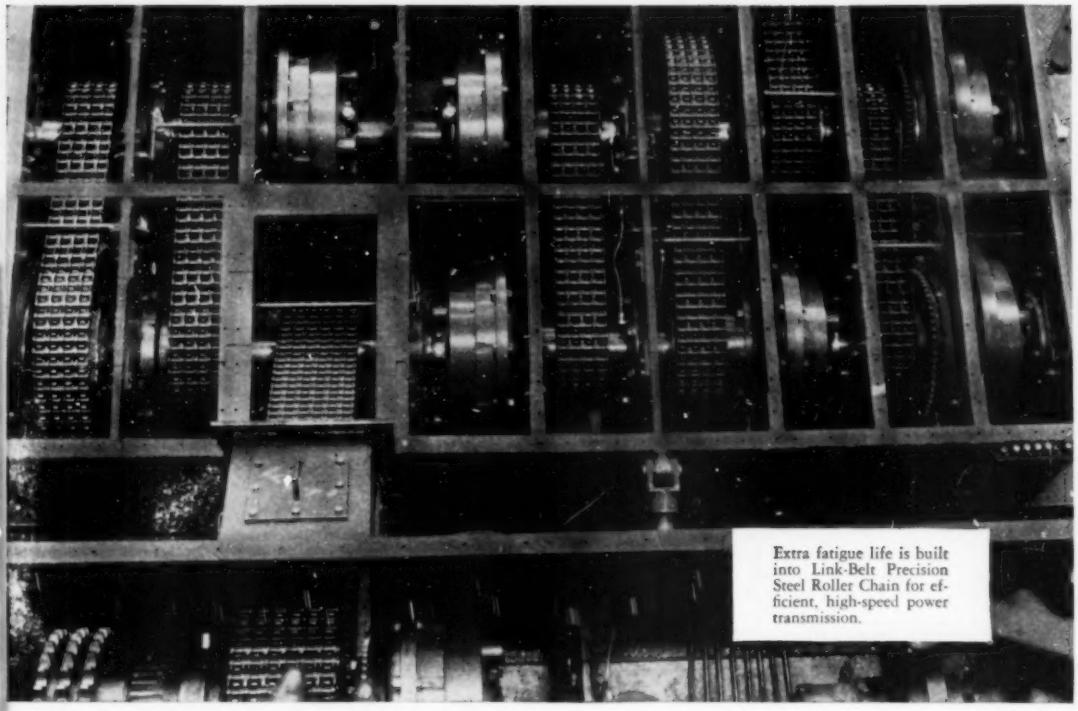
Name .....

Company .....

Street .....

City ..... State .....

No ONE chain serves



Extra fatigue life is built into Link-Belt Precision Steel Roller Chain for efficient, high-speed power transmission.

LINK-BELT builds the world's most complete chain line... offers you the RIGHT chain for your specific requirements

Silent chain, for smooth, high-speed drive service, from fractional to 2500 horsepower.

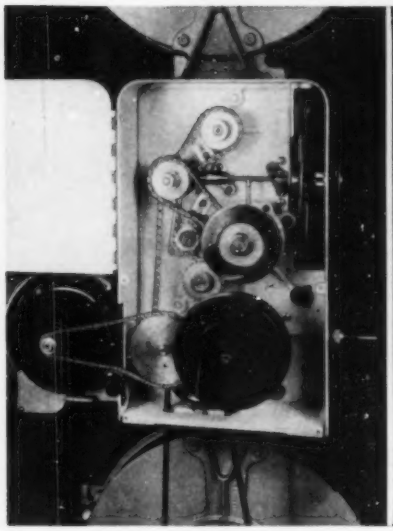
Precision steel roller chain, for long-lasting drives and conveyors, also double pitch and multiple widths.

Class 55 bushed roller chain, of many designs, for drives, conveyors and elevators, rugged and durable.

Combination chain, with cast links pin-coupled to steel sidebars, for rugged conveyor and elevator duty.

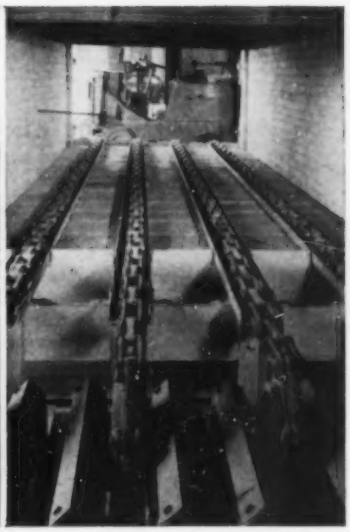
Class H pintle chain, one of many cast of malleable iron or stronger Pramal, with closed pin joints.

every purpose...



3/16" pitch, smallest of a large family of fast-running silent chains, assures accurate speeds in this theatre sound projector.

For this farm machine, Double-Pitch Roller Chain and Steel Link-Belt were selected to meet specific drive and conveying needs.



Long life under severe conditions. Here L-B drop-forged steel rivetless chains move castings through a heat-treating furnace.

THERE'S just *one* type of chain that *best* meets the requirements of any given job. And no "general purpose" chain can do it as well. That's why Link-Belt builds the world's most complete line of chains and sprocket wheels.

There's a Link-Belt chain for every job—Silverstreak Silent Chain for high speed drives up to 4000 fpm and 2500 hp... Precision Steel Roller Chain for moderately high-speed drives and conveyors... any one of dozens of steel and malleable chains for power transmission, conveying and elevating service with an infinite variety of attachments. Large or small, Link-Belt builds them all.

Remember, too—when you see a chain with the Link-Belt trademark, you can be sure it's made to the highest standards. Link-Belt's modern plant facilities assure greater refinements of manufacture. Exact control of materials and processes gives increased uniformity... longer chain life.

12,500

LINK-BELT

CHAINS AND SPROCKET WHEELS

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Various (South Africa). Offices, Factory Branch Stores and Distributors in Principal Cities.

Class RC crescent flat top chain, conveys bottles, cans, etc. separately over curving paths, various designs.

Steel Link-Belt, similar coupling to cast Ewart Detachable, economical for light drive and conveying service.

Silent chain wheel, precisely machined to mesh with chain, in a full range of diameters, widths and designs.

Roller chain sprocket, with accurately cut, hardened teeth, in all diameters, widths and hub designs.

Cast tooth sprocket, gray iron, steel or file-hard Flint-Rim, for cast, combination, forged or fabricated chains.

NOW... you can get QD

TRADE MARK

QD TRADE MARK

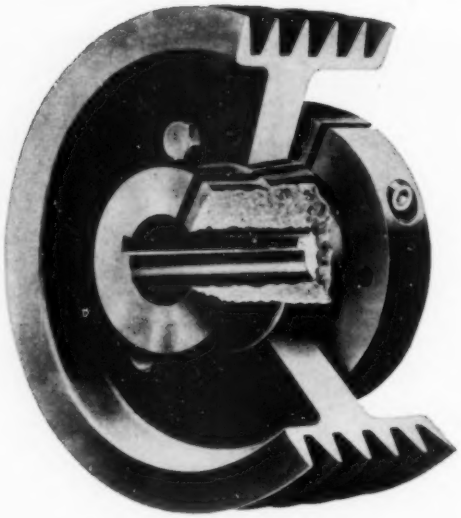
— ORIGINAL WITH WORTHINGTON
— STANDARD WITH ALL INDUSTRY

Today, more machinery is equipped with QD sheaves than with any other hub-and-rim combination.

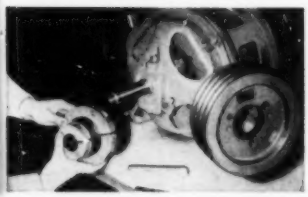
The men who install and change sheaves prefer the convenience of its two-part, taper-mated construction and the permanent alignment of hub on shaft. Also, Worthington is the *only* manufacturer to design each size, individually, for the load it has to carry—rather than to proportion all sizes from one design. And the trim QD appearance is a sales asset.

Specify Multi-V-Drive with QD sheaves and Worthington-Goodyear EC Cord V-belts on your machinery.

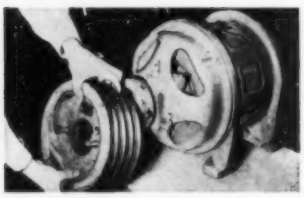
Write for Bulletin V-1400-B7F, addressing our Buffalo office.



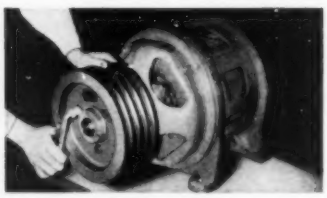
WORTHINGTON QD SHEAVE
THE ORIGINAL TAPERED CONE-GRIP SHEAVE



EASY TO GET ON



EASY TO GET OFF



YET ALWAYS TIGHT ON THE SHAFT

CHECK THESE QD FEATURES AGAINST ANY V-BELT DRIVE

...and you'll see why QD means easiest speed change and longest V-belt efficiency.

1. Sheave comes in two parts for easy mounting: light hub first, then heavier rim on tapered hub —or, as one-piece assembly.*
2. Split hub—easy to mount, even on over-size shaft.†
3. Interchangeable rims—hubs for every bore.†
4. Clamped hub holds position on shaft when rim size is changed —no realignment problem.*
5. Taper-mated hub and rim easily mounted in any position for friction cone grip and positive press fit on shaft.†
6. Shaft key lock prevents key from drifting.*
7. Large, long pull-up bolts hold better, and can be used as jack screws to remove rim.†
8. I-beam spokes on driven sheave help carry heavier load with less weight.*

* WORTHINGTON EXCLUSIVE

† WORTHINGTON ORIGINAL

WORTHINGTON-GOODYEAR EC CORD V-BELTS

Each endless cord carries its equal share of belt load—each belt carries its equal share of drive load. Cord location in neutral axis reduces internal friction.

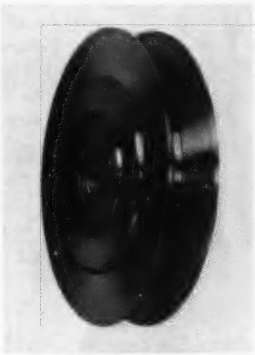
Also: steel cable V-belts for high capacity in minimum space, minimum stretch or creep: HY-T cord V-belts for shock load conditions.

advantages over the complete range of sheave sizes

...also FHP pulleys in other styles

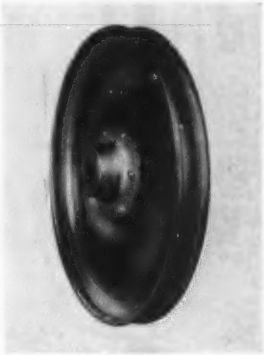
QUICK-DETACHABLE V-PULLEYS FOR FHP DRIVES

The original Worthington QD Junior V-Pulley clamps the shaft tighter than any other FHP V-pulley on the market—and reduces maintenance time to a minimum. Taper-bored cast-iron rim, tightened on tapered split hub, creates a positive press fit on the shaft—won't loosen due to shock or pulsating load. Yet it's easily removed.



BORED-TO-SHAFT-SIZE SOLID MACHINED STEEL V-PULLEYS
—3½ in. and under

Precision-bored to insure proper fit on the shaft. The groove cross-section is accurate and uniform, so the belt seats properly and wears longer. A standard key seat is used with hollow head set screw.



PRESSED-STEEL V-PULLEYS

Quality at lowest cost. Heavy gauge, welded steel. Equal weight distribution assures accurate balance and vibrationless operation. Accurately formed grooves, precision bored. Available in a complete range of sizes and bores.

CAST IRON BORED-TO-SUIT V-PULLEYS

Accurately machined for true running and perfect balance. Complete range of sizes in single and two-groove.

FHP V-BELTS

A complete range. Elastic envelope takes wear, protects carcass, transmits load to heavy cords. Cord location in neutral axis reduces internal friction.

Write for Bulletin FHP-100 on FHP pulleys and FHP belts, addressing our Buffalo office.

WORTHINGTON

WORTHINGTON PUMP AND MACHINERY CORPORATION
MULTI-V-DRIVE SALES DIVISION
Buffalo, N. Y. · *General Offices*, Harrison, N. J.

THE GOOD RIGHT HAND OF INDUSTRY

POWER TRANSMISSION: sheaves, V-belts, variable speed drives
PUMPS: centrifugal, power, rotary, steam
AIR COMPRESSORS: water-cooled, air-cooled

MV-1-2

SAVE metal

SAVE man-hours

SAVE money

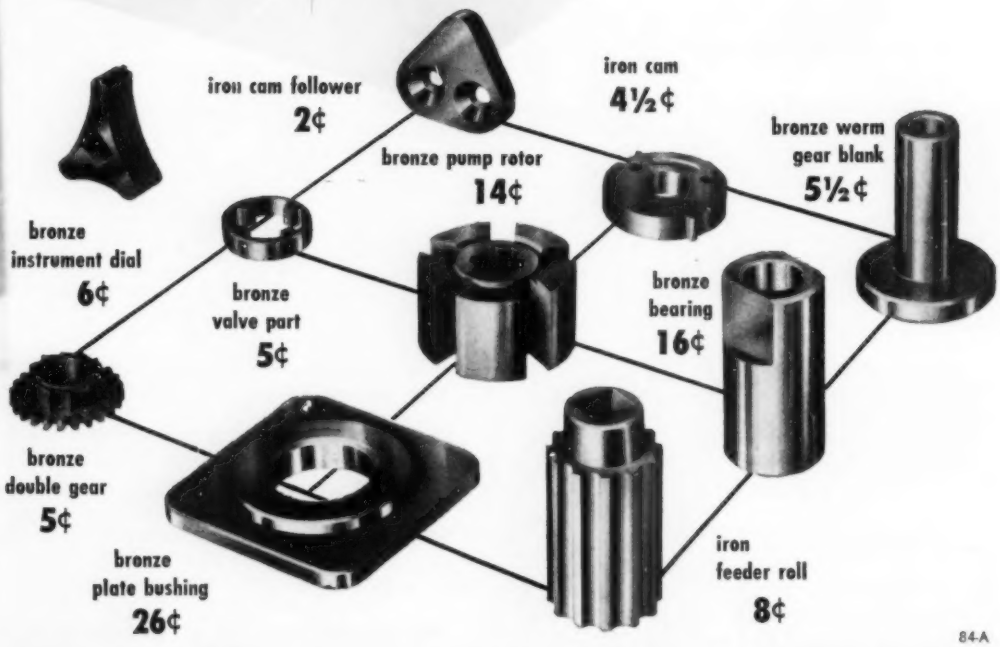
By using Gramix parts, die-pressed of powdered metal mixtures, in place of machined parts in products, you can make three important savings—savings that are becoming more vital with every day that passes.

GRAMIX PARTS SAVE METAL. They are made with minimum scrap and waste . . . pound-for-pound more pieces can be produced from Gramix than can be obtained from solid or bar stock that is in tight supply today.

GRAMIX PARTS SAVE MAN-HOURS and machining time because, they are die-pressed to tolerances as close as .0005" . . . the machining time saved can be made available for defense weapon production.

AND, GRAMIX PARTS SAVE MONEY because in quantity lots they can be produced at considerable less cost than identical machined parts. Then too, Gramix parts are oil-impregnated for self-lubrication thus eliminating the need for servicing. Add up the advantages and you'll see why it'll pay you to go to Gramix . . . the leader in the powdered metal field. Write us for the full story.

with GRAMIX® parts



84-A

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

A FOOTE BROS. DRIVE

FOR ANY POWER TRANSMISSION NEED

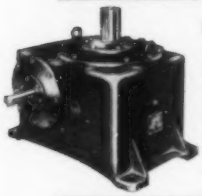
Any requirement for power transmission equipment can be met from Foote Bros. complete line of enclosed gear drives.

Nearly a century of engineering and manufacturing experience is back of these drives. Three large plants contain the newest in gear cutting equipment. New techniques in manufacture—better control of materials—improved manufacturing methods—all assure superior enclosed gear drives. Mail the coupon below for bulletins in which you are interested.

LINE-O-POWER

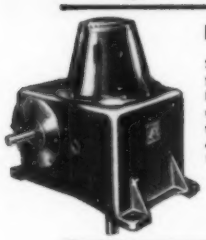
Economical in original cost and operation, these drives incorporate Duti-Rated Gears which have file-hard tooth services and ductile cores, assuring long life. Compact in design. Available in double or triple reductions, with ratios from 5 to 1 up to 238 to 1 and capacity range from 1 up to 200 horsepower. Write for Bulletin LPB.

VERTICAL DRIVES



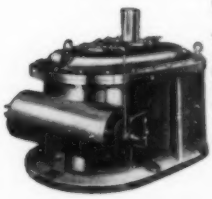
HYGRADE

A quality line of heavy-duty drives, incorporating precision worm gearing that assures high efficiency and load-carrying capacity. Vertical output shaft may extend upward, downward or both. Ratios from 4½ to 1 up to 4,108 to 1. Capacity up to 260 horsepower. Write for Bulletin HGA.



HYTOP

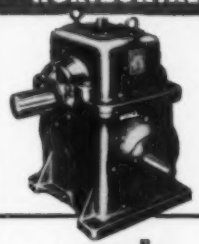
Similar in design to the Hygrade Vertical Drives, but with wider, low-speed bearing span to accommodate long, unsupported vertical output shaft extensions. Vertical output shaft may extend upward, downward or both. Write for Bulletin HGA.



WORM-HELICAL

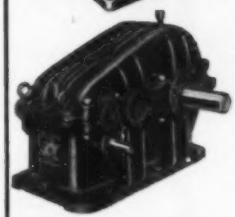
These drives are admirably suited to applications which require horizontal input and vertical output shafts for heavy-duty service. Available in ratios from approximately 30 to 250 to 1 and a capacity range up to 120 horsepower. Write for information.

HORIZONTAL DRIVES



HYGRADE

High quality, heavy duty, enclosed worm gearing that assures high efficiency and load-carrying capacity. Available in a wide range of types to meet any need. Ratios from 4½ to 1 up to 4,108 to 1. Capacity up to 260 horsepower. Write for Bulletin HGA.



MAXI-POWER

Heavy-duty helical gear drives. Available in single reduction units, ratios up to 9.91 to 1; capacities up to 1,550 horsepower; double-reduction units, ratios from 9.32 up to 71 to 1, capacities to 1100 horsepower; triple reduction units, ratios from 79 up to 360 to 1, capacities up to 420 horsepower. Write for Bulletin MPB.

FOOTE BROS.-LOUIS ALLIS *Gearmotors*

A compact line of gearmotors in 17 sizes in single, double and triple reductions, incorporating Duti-Rated Gears that assure long wear life and maximum load-carrying capacity. Units use Louis Allis high quality motors—available in a wide range of enclosures to meet any condition. Write for Bulletin GMA.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard, Chicago 9, Illinois

FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. W, 4545 South Western Boulevard, Chicago 9, Illinois

Please send me the bulletins checked below:

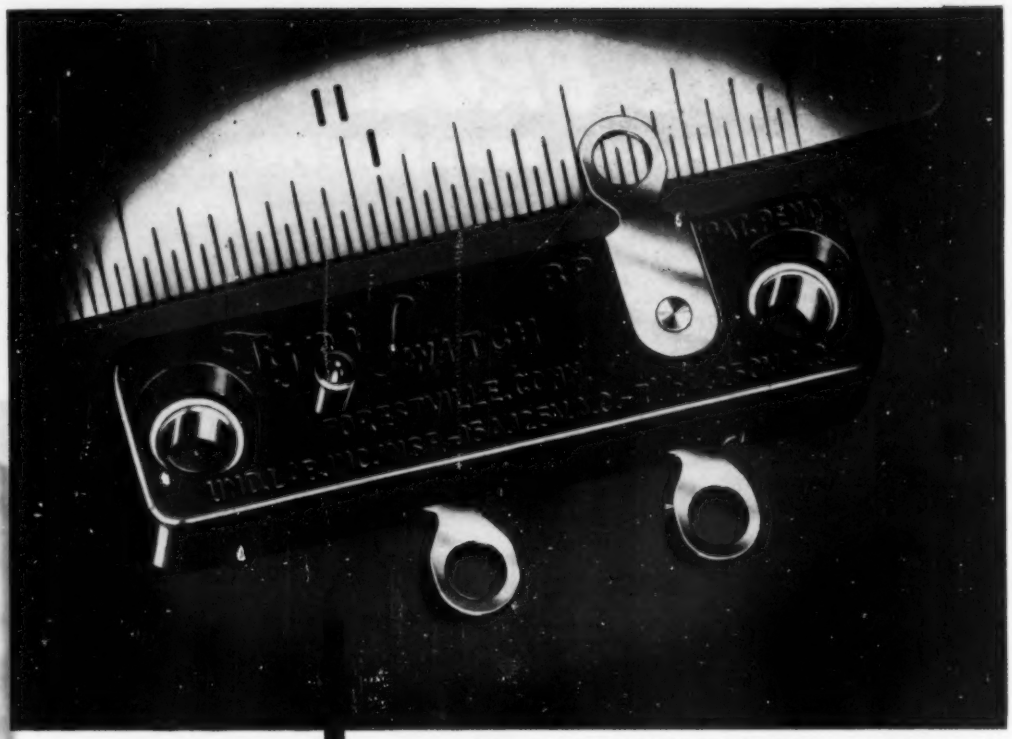
- ☐ Bulletin HGA { Horizontal Hygrade / Vertical Hygrade / Vertical Hytop }
- ☐ Bulletin LPB Line-O-Power
- ☐ Bulletin MPB Maxi-Power
- ☐ Bulletin GMA Foote Bros.-Louis Allis Gearmotors

Name.....*Position*.....

Company.....

Address.....

City.....*Zone*.....*State*.....



Illustrated: Model BP Single-pole, double throw 15 A., 125 V. A-C

The only miniature snap switch

. . . where size and high rating come to terms with cost

Here's a new ally for the design engineer in his effort to keep quality high and cost low. TYNISWITCH fits in the smallest places, yet handles the load of switches much larger and more expensive. Thorough laboratory tests have proven its dependability and durability at high operating speeds and over millions of cycles.

In its simplified construction, TYNISWITCH introduces new principles of switch design that cut costs. High force-to-inertia-ratio spring blade inhibits mechanical resonance, enables high switching rate with positive bounceless closure. All these and other features add up to efficient switching at low cost.

TYNISWITCH engineers are fully qualified to work with you on the economical development of your special application switches. Write for engineering design sheets.

New Du Pont

TEFLON*

TRADE-MARK

Polytetrafluoroethylene Coated Glass Fabrics, Tapes and Laminates

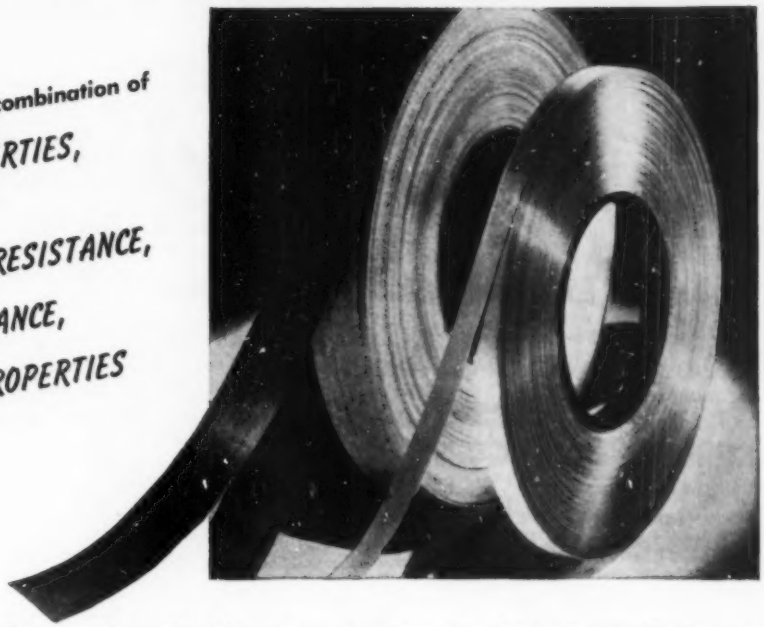
offer an outstanding combination of

ELECTRICAL PROPERTIES,

HIGH and LOW TEMPERATURE RESISTANCE,

CHEMICAL RESISTANCE,

NON-ADHESIVE PROPERTIES



HERE ARE amazingly versatile products made from woven glass fabrics coated with polytetrafluoroethylene for such applications as:

ELECTRICAL—in electronic equipment, motor and generator insulation, transformers and coils, cables, other electrical uses, they provide insulation meeting Class H requirements. May be used continuously at 200°C. (392°F.), or for short periods at 250°C. (482°F.) or slightly higher. Creasing parallel to fibers or diagonally does not result in loss of good electrical properties. "Teflon" Coated Glass Fabrics do not show embrittlement or cracking when sharply creased, at temperatures as low as -30°F. Where sharp creasing is not involved, flexibility is maintained even at -100°F. Extremely low loss characteristics make them especially valuable in radar and electronic equipment. The laminates possess exceptionally high arc resistance. And the "Teflon" products have good dielectric strength, low dielectric constant, and negligible water absorption.

CHEMICAL—"Teflon" Coated Glass Fabrics, Tapes and Laminates have outstanding solvent and chemical resistance. "Teflon" is unaffected by all known chemical agents, excepting molten alkali metals, and under special conditions fluorine and chlorine trifluoride. Typical use: conveyor belts where hot corrosive salts and other materials must be moved quickly and safely.

RELEASE FROM STICKING—The surface of any "Teflon" Coated Glass Fabric or Laminate exhibits remarkable anti-adhesive and anti-friction qualities. In general, sticky, resinous or moist materials do not readily adhere, eliminating the need for blocking or lubricating release agents. Typical uses: heat sealing machines and conveyor belts for use in baking, candy and food industries where sanitation and easy release of fragile commodities are important.

You can now obtain "Teflon" Coated Glass Fabrics, Tapes and Laminates in limited quantities for experimental purposes and field tests. A standard line of single-ply materials and of laminates is available. For additional information, fill out and mail the coupon below.

*"TEFLON" is Du Pont's trade mark for its polytetrafluoroethylene and its products containing polytetrafluoroethylene, including among others—finishes, primers, enamels, intermediate enamels, wire enamels, coated glass fabrics, tapes, laminates, etc.

DU PONT

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. . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Fabrics Division, Empire State Bldg., New York 1, N. Y.

Please send me more data on "Teflon" Coated Glass Fabrics.

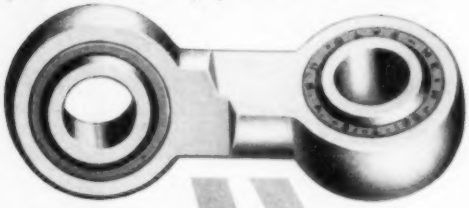
*Name*_____ *Title*_____

*Address*_____

HOW HEIM *Spherical Bearing* ROD ENDS

CAN BE ADAPTED TO . . .

Special Applications



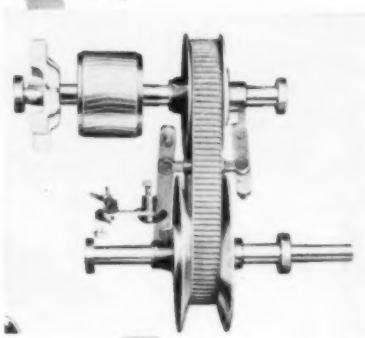
ANOTHER ADAPTATION OF THE UNIBAL PRINCIPLE

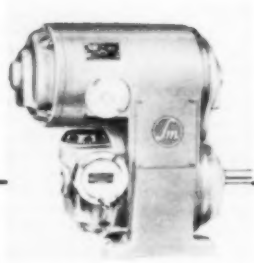
A single ball revolving in spherical bronze bearing inserts provides a larger bearing surface so that maximum radial and thrust loads can be carried. The ball is bored and honed to fit the shaft which passes through it. This is the Heim Unibal principle.

In the production of the Sterling "Speed-Trol" Vertical Mounted motor, Sterling Electric Motors, Inc., Los Angeles, Cal., chose HEIM bearings mounted in a double end offset link with an outer member of carbon steel, bronze bearing inserts, and a ball made from SAE 52100 steel heat treated.

The Internal construction of the Sterling "Speed-Trol" motor and a completed motor are illustrated here.

Whether your linkage mechanism calls for a straight rod end, either male or female type, or a special adaptation for your particular production design, HEIM will be glad to work with your engineering department in creating a better rod end construction.





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THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

Reynolds
ALUMINUM REPORTER
A SERVICE TO INDUSTRY ON ALUMINUM USES AND DEVELOPMENTS

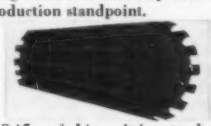
LOUISVILLE 1, KY. NUMBER 4

REYNOLDS FIRST PIG POURED 10 YEARS AGO

Integrally Stiffened Skin Developed for Airplanes

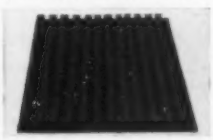
The increased pressures encountered by high speed, high altitude aircraft created new design problems. One difficulty is to get adequate skin reinforcement without increasing the dead-load to pay-load weight ratio. Even aluminum alloys that have the strength of steel do not provide the answer.

Experiments show that closely spaced T sections give the needed "beefing". However, to include them as separate structurals adds a weight penalty and labor costs for riveting mount. Milling out a thick aluminum plate to leave only a thin sheet and its reinforcing ribs is another approach. This meets weight requirements but is costly in material and machining time. It is also impractical from a mass production standpoint.



Stiffened skin as it is extruded

Presented with this problem by the Army Air Forces, Reynolds Metals Company developed a method of extruding ready-ribbed aluminum skins, without loss of metal or excessive labor requirements. A hot billet of aluminum is fed into the maw of a gigantic press at the company's Phoenix, Arizona plant and is extruded by a powerful hydraulic ram, through a specially designed die. The aluminum appears in the form of a long tube with T-shaped ribs on the outside. When cooled this tubing is cut to desired lengths, then slit, straightened and stretched to produce a flat sheet with integral reinforcement on one side. Assembly and rivets are eliminated.



Ribbed side of sheet after straightening

Present extrusion presses limit stiffened skin widths to 28 inches. Larger presses are being planned to provide the same range of sizes now common for regular rolled sheets, and possibly larger.

"Designing with Aluminum Extrusions" is a 132 page, 6" x 9" reference book that can help you make a better product at lower costs. This book is free when requested on your business letterhead. Write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

150 Million Pounds of New Capacity Now Under Way

Just ten years ago, on May 18, 1941, the first Reynolds Aluminum pig was poured at Listerhill, Alabama. Since then the company has expanded rapidly and today has an annual capacity of over 500,000,000 pounds. This includes 50 million pounds of increased production during late 1950 and early 1951 at existing plants in Arkansas and Oregon. New construction now under way at Corpus Christi, Texas will increase Reynolds present capacity by another 150,000,000 pounds. The ever-growing organization now consists of 24 plants strategically located across the country, and employs over 18,000 people.

Pouring first aluminum at Listerhill, Ala.

R. S. Reynolds' conviction of the great need for aluminum in this country was the foundation upon which plans for production were built in 1940. In effecting these plans the whole pattern of the aluminum industry was changed. For within a single year Reynolds increased the nation's prewar aluminum production rate by 50%. This, before Pearl Harbor! And the additional output played a vital role in providing the aluminum which was so badly needed during the 1941-45 war period. The conviction which started Reynolds Aluminum production in 1941—a need for U. S. preparedness—has been constantly maintained.

R. S. Reynolds, Sr.

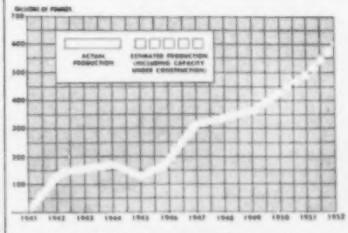
Today, the Reynolds Metals Company is constantly endeavoring to improve and expand production facilities so that a continuing and adequate supply will be available for American defense and industry. Bauxite deposits in the Caribbeans, the largest in the world, are now being developed by Reynolds to assure a nearby source of raw material for many generations. These, plus constant research to improve aluminum production methods will enable the company to keep pace with the constantly increasing demand for aluminum.

The introduction of a new primary aluminum source in 1941 has contributed greatly to the industrial growth of America. It created competition which stimulated the use of lightweight metal in the past ten years. It also provided a greater supply. Reynolds, alone, has shipped well over 3 billion pounds of aluminum to customers in this period. With an increased supply to rely on, industry has developed many new aluminum uses and applications. They can be seen today from highways to skyways, boats to buildings, in thousands of products used daily throughout the world.

Aluminum Industry Expands

Although today's mobilization requires vast amounts of material, the Aluminum Industry is adding to its facilities so that there will be a larger supply for all needs. Reynolds part in this expansion is clearly illustrated in the accompanying chart. The chart also shows the rapid production growth of the company from 1941 to 1950.

For a word and picture story on aluminum production and advantages, write for the 96 page book, "The A. B. C.'s of Aluminum." Sent free, together with a complete index of Reynolds Aluminum design and fabrication literature, when requested on your business letterhead. Write to Reynolds Metals Company, 2576 South Third St., Louisville 1, Ky.



650,000,000 pound capacity in 1952

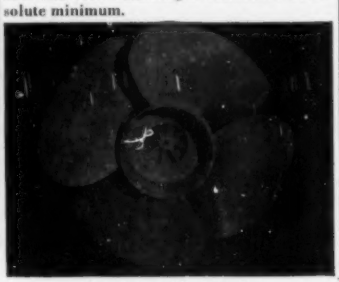
MORE INFORMATION AND NEWS ABOUT ALUMINUM ON NEXT PAGE

Fans Within Fans— A New Development

Many manufacturers have improved the efficiency of their motor powered fans by adopting lightweight aluminum fan blades and hubs. When the Mathes Company of Fort Worth, Texas, consistently applied modern design ideas to aluminum, they came up with still further improvement.

The streamlined Mathes fan

Fabrication of the Mathes Fan is as far from the conventional as is its unique design. The aluminum fan blades are blanked out and formed. They are then set in precise position in a die-casting mold. The entire hub is die-cast around the blades so they become an integral part of the hub and in perfect alignment. Obviously, this cuts down assembly time and cost. Balancing is reduced to an absolute minimum.



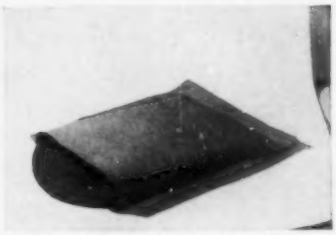
Note internal hub design

The Mathes Company's efforts have resulted in a fan that keeps its motor cool. It is built with a conical nose section which clears the fan hub and leaves an open section between the two parts. In the nose is an interior fan which directs a stream of air over the motor, keeping it cool for efficient operation at ½ over the rated horsepower. When a ⅛ hp motor is used the power of a ⅙ hp unit is obtained, without overheating or undue wear on the motor. Although operating costs are practically the same as for a full ⅙ hp, the size and weight of the motor are less. Aluminum fan blades and hub also save weight.

There are opportunities continually arising where new designs and new ideas in aluminum fabrication can mean great advancements in the sale and popularity of some product you may be making.

The 12-page Product Design catalog, published by Reynolds, gives condensed information on fabrication, finishes, mill sizes and engineering tables for aluminum. Write Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky for your copy today.

Aluminum foil used as Grade A wrap



Foil-on-kraft bag with vinyl heat-seal coating

Plain Aluminum Foil Re-enlists for Defense

Today, with the rapid increase in defense production, large quantities of Reynolds plain aluminum foil are going "back into uniform", much of it for the protection of packaged parts.

It is particularly effective as a Grade A initial wrap and was used to great advantage during World War II for the protection of surgical instruments. The present heavy demand is for both military and essential defense uses. This protective wrap seals vital parts against corrosive effects of the most severe climates around the world, from Arctic freeze to humid penetration of the Tropics. Plain aluminum foil is approved under "Spec. JAN-B-148 Barrier, aluminum foil as a Grade A grease-proof barrier."

Aluminum foil is wax-free and grease-proof on both sides. Either side can be used next to the packaged part. When properly used, it forms a positive moisture-vapor barrier which prevents any preservative greases from drying or hardening. It does not become weakened when wet, or is it affected by long exposure to dry air or extreme temperature changes.

Aluminum foil offers maximum conformity to any shaped object. This feature eliminates the necessity of taping or tying which saves time in packaging and, in some cases, considerable material.

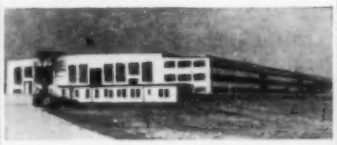
The use of plain aluminum foil is simple. After cleaning and preserving, the part is wrapped in the proper gauge of foil. It is then packaged according to approved methods described in "Spec. JAN-P-116 Preservation, Methods of."

At the present time, grease-proof aluminum foil for parts packaging is available for defense orders. For further details and information on its application to particular products according to government specifications, call the Reynolds office listed under "Aluminum" in your classified telephone directory, or write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

Unique Aluminum Service Offers 30% Scrap Savings

Many manufacturers are slashing costs, solving production problems through the use of Reynolds Aluminum Fabricating Service. This service, which provides complete facilities for any desired aluminum blank or finished part, offers an average 30% scrap saving.

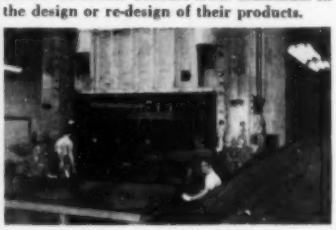
Reynolds pioneered the service of shipping parts instead of sheet during World War II. This made aluminum scrap available for immediate re-use, without tying up valuable transportation in the two-way hauling of unusable metal. Today, Reynolds is again supplying blanks and parts in this more efficient and economical way to expedite defense orders. Reynolds plants have round-the-clock guard systems required for such restricted military production.



One of Reynolds fabricating plants

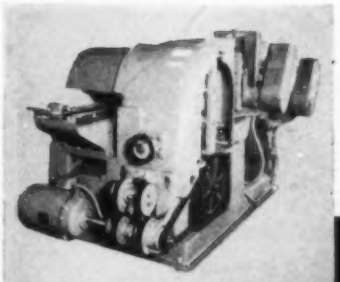
Included in Reynolds fabricating facilities are over 100 presses — mechanicals ranging from 5 to 1700 tons and hydraulics from 50 to 5000 tons. There is also a fully complementing line of equipment for shearing, forming, spinning, tube bending, roll forming, roll shaping, riveting, welding and finishing, to assure a steady flow of parts in quantities to meet every requirement.

A committee of aluminum design and fabricating specialists reviews each production item to determine if improvements or lower costs can be effected. The same staff also works with manufacturers' engineering departments to assure maximum benefits from aluminum in the design or re-design of their products.



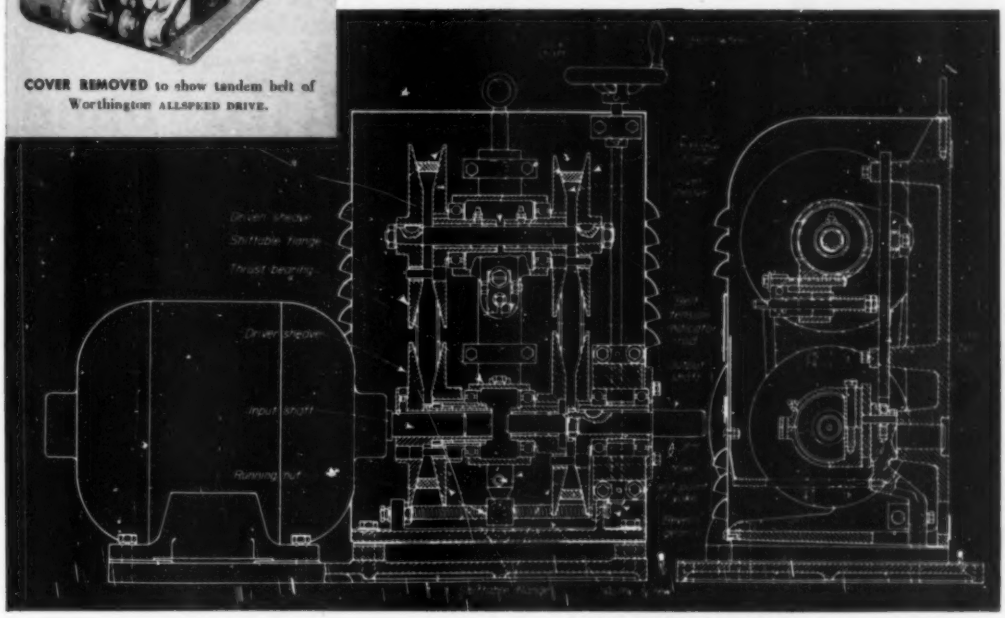
1700 ton mechanical press

For complete information on how to avoid hidden costs in your parts production, call the Reynolds office listed under "Aluminum" in classified telephone directories. Or write to Reynolds Metals Company, 2065 South Ninth Street, Louisville 1, Kentucky.



COVER REMOVED to show tandem belt of Worthington ALLSPEED DRIVE.

Two Belts Take Up Less Room Than One!



CROSS-SECTIONAL views of Worthington ALLSPEED MOTOR DRIVE.

New variable speed drive gives wider speed variation in limited space

And belt *replacement* is reduced, too!

Those are two of the reasons why the new Worthington ALLSPEED DRIVE is your best specification for variable speed control.

The "tandem-belt" design gives a greater range of instantaneous, stepless variations than the single belt used in other variable speed drives. And it permits using a *narrower* belt than other drives—this means less wear from flexing and compression, longer life.

Other advantages: Easy belt replacement—don't have to dismantle the unit • Automatic positive belt tensioning • All wearing parts bronze-bushed • All ball bearings shielded and life-lubricated • In-line input and output shafts • Can be run in either direction.

MODELS TO SUIT YOUR DESIGN

Six sizes from 1-15 hp; up to 16-1 range of variation.

Covered or skeleton models—or supplied less any parts, such as without shifting parts for attachment to your shifting mechanism.

With or without built-in motor—standard NEMA Frame 1750 rpm motor.

Upright or horizontal frame.

Extended control yoke available.

Send coupon for Worthington Allspeed Drive bulletins AS-1600-B3 and AS-1600-B4. Worthington Pump and Machinery Corporation, Worthington Allspeed Drive Division, Holyoke, Massachusetts.

WORTHINGTON

AS.1.3

THE GOOD RIGHT HAND OF INDUSTRY

POWER TRANSMISSION: sheaves, V-belts, variable speed drives

PUMPS: centrifugal, power, rotary, steam

AIR COMPRESSORS: water-cooled, air-cooled

Worthington Pump and Machinery Corporation
Worthington Allspeed Drive Division
Holyoke, Massachusetts

Please send bulletins AS-1600-B3 and AS-1600-B4 on Worthington Allspeed Drive.

Name .....

Company .....

Address .....

This door is ALWAYS open

take advantage of Wolverine's open door

You are always welcome here—in our Customer Engineering Service—
where we discuss problems that deal with tubing and its various functions.

There's no point in your struggling with a tubing problem
when you can have the answer so readily here in Customer Engineering Service.

The vast experience of more than three decades of
extensive tube-making is represented within this department.
And it's all available for you to draw on without cost.

Just because tube is immobile when installed, don't dismiss it
as something that needs no more consideration than that. In its diverse forms
it can serve you efficiently or inefficiently.

The time to think about the specifications of your tube requirements is *before*
you make your installations—before you encounter difficulties—
so you can be sure that the product you are building—that
may require plain or fabricated tube—will function in the highest degree of efficiency.

WOLVERINE TUBE DIVISION
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INCORPORATED
Manufacturers of seamless non-ferrous tubing
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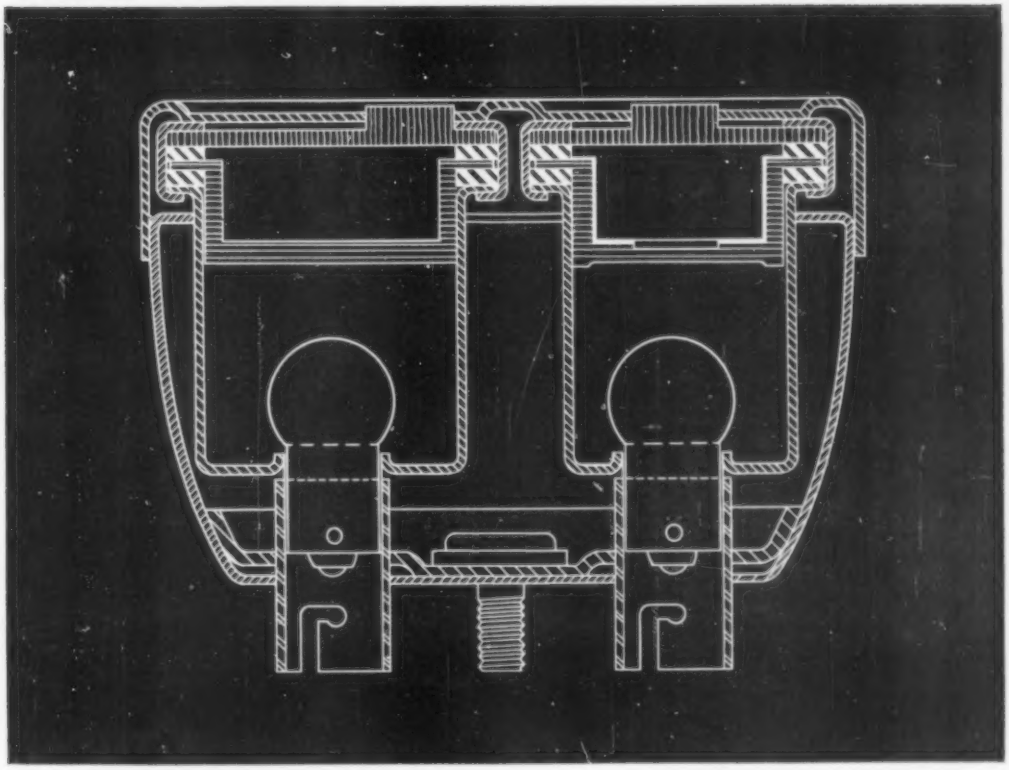


Cork-and-rubber gaskets to meet military needs

Here are some of the questions design engineers ask when faced with the problem of choosing cork-and-rubber gasketing materials for military applications.

Do Armstrong's Cork-and-Rubber Compositions meet government specifications?

Yes. There are two classes in MIL-G-6183 (formerly AN-G-32) covering cork-and-rubber gasket materials, each with three grades. There is an Armstrong Composition designed to meet each of the six grades.

What about new cork-and-rubber materials for military equipment for which no suitable material is known?

Armstrong's Research Laboratories are ready to develop new cork-and-rubber materials to meet specific military requirements. Discuss your needs with your Armstrong representative . . . or write.

In what forms are cork-and-rubber gasket materials available?

Armstrong's Cork-and-Rubber is supplied in sheets, ribbons, adhesive-backed tape (made to meet MIL-T-6841, formerly AN-T-84), and in either lathe-cut or die-cut shapes.

What basic polymers are available in cork-and-rubber compositions, and how does the fluids resistance of each compare with the corresponding straight rubber?

Neoprene, Thiokol, Buna N, and Buna S rubbers are available in Armstrong's Cork-and-Rubber Compositions. Neoprene, Buna S, and Buna N are available in sponged cork-and-rubber materials. The fluids resistance of cork-and-rubber compositions is comparable to straight rubber compounds of corresponding polymers.

Does Armstrong have facilities for testing applications where cork-and-rubber is recommended?

Yes. The laboratories at Armstrong are completely equipped for testing.

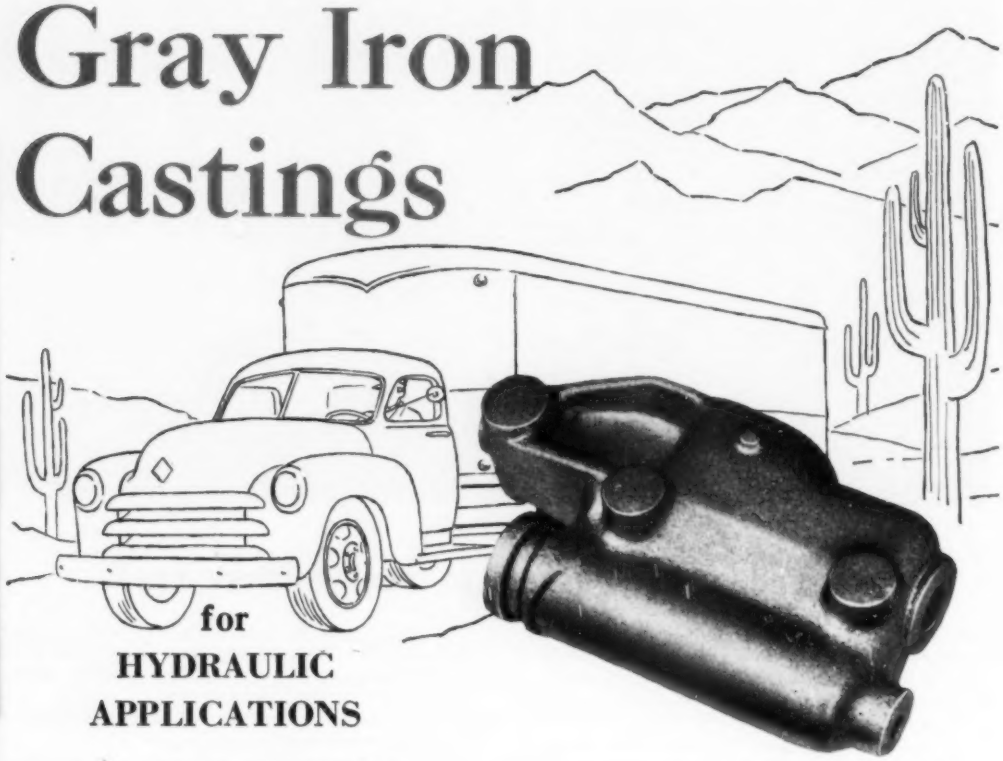
Are these materials the same as those used in civilian equipment?

Yes. In the drawing above, for example, one of Armstrong's Cork-and-Rubber Compositions provides a weathertight seal on a stamped signal lamp housing. It conforms to the surface irregularities in both flange and lens and cushions the lens against breakage. In addition, cork-and-rubber has good resistance to fatigue and little tendency to stick to flanges. This means tight resealing when broken lenses or burned-out bulbs are replaced.

For further information on cork-and-rubber compositions and gasket selection, call your Armstrong representative or refer to Armstrong's Gasket Materials manual in Sweet's file for product designers. For a personal copy of this manual, write Armstrong Cork Co., Gaskets and Packings Dept., 7105 Arch St., Lancaster, Pa.

ARMSTRONG'S *Gasket Materials*

Eaton Permanent Mold Gray Iron Castings



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- **Free machinability**
- **Dense, homogeneous structure**
- **Freedom from leakage under pressure**
- **Machines to high, mirror-like finish**
- **Properly annealed; no growth or distortion after machining**

Send for your copy of the illustrated booklet, "A Quick Picture of the Eaton Permanent Mold Process for Producing Gray Iron Castings."

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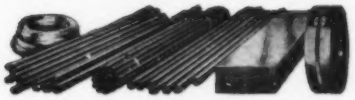

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COPPER ALLOY BULLETIN

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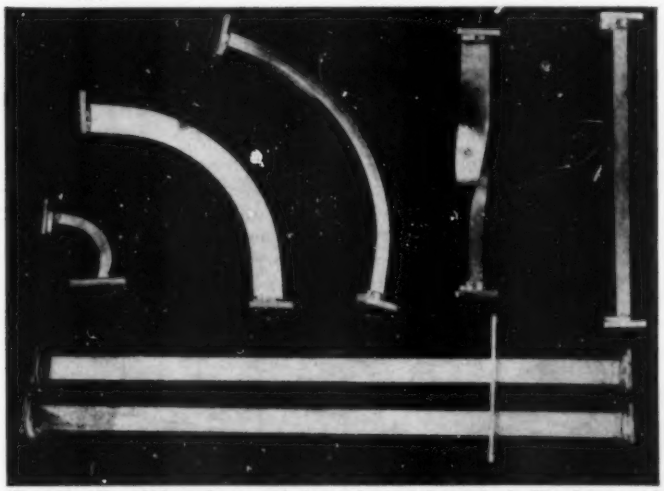


Waveguide tubing which can be accurately bent and twisted due to the ductility of commercial bronze. Flanges are silver soldered to tubing. Courtesy Carl W. Schutter Mfg. Co., Lindenhurst, N. Y.

Copper-Base Alloys Prove Value In Growing Field of Microwaves

The electrical characteristics of coaxial and waveguide components in microwave transmission lines are as dependent on the precise physical dimensions as on the conductivity of the materials used. The greater the conductivity of the materials the more efficient the lines become.

Copper-base alloys are widely used because of their good workability, machinability, conductivity and the ease with which they may be joined through either brazing, welding or soft or hard soldering.

Corrosion Resistance Important

Two other characteristics of these alloys are also important to this type of work: Corrosion resistance and the fine manner in which they take a plate and hold it without flaking or peeling.

Since microwaves travel along the surface of a conductor, corrosion of even a minor degree would seriously impair the conductivity of the component.

Silver and copper plates are often used to improve the conductivity. Here again electrical characteristics would be impaired by a break in the plated surface. Since internal plating is involved, many difficulties experienced in plating of other metals are eliminated.

In wave guide tubing, commercial bronze (90% copper, 10% zinc) is used on the larger sizes. High electrical conductivity is sacrificed for greater strength and rigidity. Oxygen-free copper, with a conductivity of 102, compared to 44 for commercial bronze, is being proposed for the smaller tubing in work of higher frequency.

Lead Aids Machining

When machining is involved on flanges and many types of cavities, leaded commercial bronze (89.5 copper, 2% lead, 8.5% zinc) is the choice. In this alloy 2 points are lost in the electrical conductivity compared to commercial bronze but the lead increases the machinability to a point only 20% less than free machining brass rod of 100%.

Not only are accurate dimensions required on these flanges but smooth surfaces are necessary. These would be very hard to obtain unless lead were present to help machinability.

Since coaxial connectors are machined from bar stock and then silver plated to bring up their conductivity and ability to withstand corrosion, free turning brass rod (61% copper, 3.4% lead and 35.6% zinc) is the choice in most cases. This rod has the highest machinability rating of all the copper-base alloys.

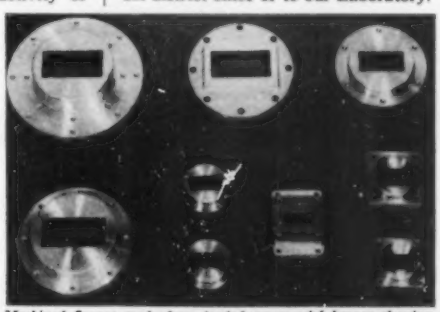
Phosphor Bronze Used

Phosphor bronze, in both wire and strip form, is used for terminal pins and jacks and for other spring applications due to its fatigue resistance to repeated flexings as well as its high tensile strength.

In the manufacture of rigid coaxial lines both tough pitch and oxygen-free copper tube or strip (formed into a tube) are generally used. Both the high conductivity of these coppers as well as their ability to withstand corrosion under many corrosive conditions make them invaluable to this application.

The copper alloys are also used for sockets, pins, shields, conductors, springs, screws, rivets and many other parts found in electronic devices.

For information on the choice of copper or copper alloys for your product, write either to Bridgeport's nearest district office or to our Laboratory.



Machined flanges made from leaded commercial bronze showing operations calling for turning, drilling, tapping and broaching. Courtesy Carl W. Schutter Mfg. Co., Lindenhurst, N. Y. (6636)

We'll help you design a better spring

● Maybe the performance characteristics can be improved. Maybe the size can be cut, or installation simplified.

Maybe you're using a steel that's all too good for the job the spring has to do. That could put your costs way out of line—and waste precious alloys.

If you want to be sure that you're getting the most out of the springs you use, submit your blueprint or sketch to our spring engineers. These crack designers have worked with countless manufacturers to produce springs to a specified performance, configuration, size, corrosion resistance or price. They've picked up a wealth of experience that can be put to work for you—if you say the word.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO • COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM, SOUTHERN DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

AMERICAN Quality SPRINGS

UNITED STATES STEEL

A message from Monsanto Plastics

To the men who are again expected to perform production miracles...

We wouldn't attempt to detail the many current design and production problems that you somehow must find a way around or over.

But we do know this: it's almost inevitable that someone in your company will sooner or later come up with the question: *"What about plastics?"*

It's a good question

The chances are that plastics *can* lend you a helping hand. They're versatile, certainly, with a wide range of physical properties and performance characteristics. They're ideal for quantity production of precision parts, by compression, injection, extrusion or fabricating methods. They require a minimun of finishing.

But there are several things to consider before you plan to apply plastics to your production and design problems.

Things to consider

First, remember that many plastics are already in short supply—and are likely to remain short, in spite of the efforts of Monsanto and other material producers to expand output. Far from being "substitutes," plastics today are *esential materials* in their own right, and of increasing importance to defense industry.

Remember, too, that plastics can't do every job. What is a sound application for one plastic may be a poor one for another. But . . . *used wisely,* in the countless applications where they do fit . . . plastics can help speed and improve the nation's output of essential goods.

The Technical Council

We have here at Springfield a panel of ten specialists in different plastics fields—the Monsanto Plastics Technical Council—which is set up to study your particular production and design problems and make recommendations. We have, too, a wealth of information about plastics molders and fabricators all over the country. For assistance of the Technical Council . . . for information on competent molders or fabricators *in your own area*... and for data on Monsanto's "family" of plastics materials, I suggest you write direct to me.

No matter how small your plastics problems, or how big, drop me a line. I'll see that your letter gets immediate attention.

Sincerely,

James R. Turnbull

James R. Turnbull
General Sales Manager

MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Mass.

Planes fly . . . ***Ships sail . . .*** ***Motors run . . .***

. . . with PLASTICS serving in vital spots. Most modern of materials, plastics serve the nation's defense in countless, all-important ways. USE THEM WISELY!

The big MONSANTO *family of plastics*

SERVING INDUSTRY . . . WHICH SERVES MANKIND

Is this clue to quality on your product?

Can you find the clue . . .

. . . to quality?
X marks the spot . . .

Yes! **a PHILLIPS SCREW**

Phillips Cross-Recessed Head Screws are found on everything from washing machines to postage meters.

They are your assurance of a well built, quality product . . . providing correct fit, tightness at all fastening points.

PHILLIPS Cross-Recessed-Head SCREWS

THIS ADVERTISEMENT is part of the current campaign aimed at the 14 million readers of The SATURDAY EVENING POST.

BY USING PHILLIPS SCREWS on your product, you prove *on sight* that you use extra care in manufacture. The public knows that X marks the spot — the identifying X formed by the cross-recess on the head of every Phillips Screw. It is the mark of extra quality.

These screws — wood, machine or tapping — add structural strength, set up tighter, resist the loosening effect of vibration. They are speedier—and cost saving because they save time, work, money. They start faster, eliminate driver skids, damaged parts, split screw heads. They make good workers out of green help — fast!

Be sure to include Phillips Cross-Recessed-Head Screws in your specifications.

PHILLIPS *Cross-Recessed-Head* SCREWS

X marks the spot . . . the mark of extra quality

AMERICAN SCREW CO. • THE BLAKE & JOHNSON CO. • CAMCAR SCREW & MFG. CORP.
CENTRAL SCREW CO. • CONTINENTAL SCREW CO. • ELCO TOOL & SCREW CORP.
GREAT LAKES SCREW CORP. • THE H. M. HARPER CO. • NATIONAL LOCK CO. • PARKER-KALON CORP.
PHEOLL MANUFACTURING CO. • ROCKFORD SCREW PRODUCTS CO. • SCOVILL MANUFACTURING CO.
SHAKEPROOF INC. • THE SOUTHINGTON HDWE. MFG. CO. • WALES-BEECH CORP.

THE FASTENERS OF TODAY . . . AND OF THE FUTURE

design
engineers
know...
there's no guess when it's a finish by...
STANDARD
For years, Design Engineers have specified with confidence, products which have been finished with Industrial Finishes by STANDARD. That's because they recognize and appreciate the advantages of a product whose finish gives longer, more durable protection through years of hard wear and abuse and still continues to look attractive.
There can be no doubt that products and equipment treated with Finishes by STANDARD consistently give finer performance and service in spite of punishing conditions.
Finishes to meet U. S. Government specifications.
STANDARD VARNISH WORKS
Makers of Fine Finishes Since 1870
NEW YORK LINDEN, N. J. CHICAGO
Linked to Industry
Superior on-the-job performance and quality in Baked Industrial Finishes by STANDARD to Industry since 1870.

ANOTHER UNIQUE HOLTZER-CABOT PRODUCT

This adjustable motor satisfies a long-felt need. It converts AC electrical energy directly to mechanical energy, without use of tubes or other converting equipment. And its advanced design combines many other features. For example—

- standard controller provides 12 speeds with approximate 7 to 1 range, for instance, 3500 RPM to 500 RPM
- dial control gives smooth, instant change-over from one speed to another
- each speed setting remains constant regardless of variations in load
- instant starting at desired speed—no warm-up period, no lag
- maximum torque for starting under load and for rapid acceleration
- compact—no auxiliary equipment required—ideal for use as a built-in unit
- can be mounted for either local or remote control
- economical—the lowest-price motor unit of its kind, and easy to maintain

This new multi-speed motor is made for AC, single phase, 115 or 230 volts. It is suitable for any application where an adjustable-speed DC motor is used, and has an additional advantage—the starting and maximum torques increase rapidly at high speeds. This motor can be built to operate at speeds as high as 8000 RPM. (A *single-speed* model with the same characteristics is also available.) The fact that the RBA or RWA motor has a service-life comparable to that of a DC motor opens up many new and important application possibilities.

Holtzer-Cabot builds precision motors in a variety of types, ranging from the small instrument sizes up to heavy duty 1½ horsepower units. They meet demanding specifications for such varied applications as office and recording machinery, machine tools, fans, pumps, hoists, blower units, farm equipment, etc.

Into each Holtzer-Cabot motor goes the same engineering skill and manufacturing excellence that through the years have made Holtzer-Cabot the standard of high quality in motors. Write today for expert assistance in solving your motor problems.

HOLTZER-CABOT

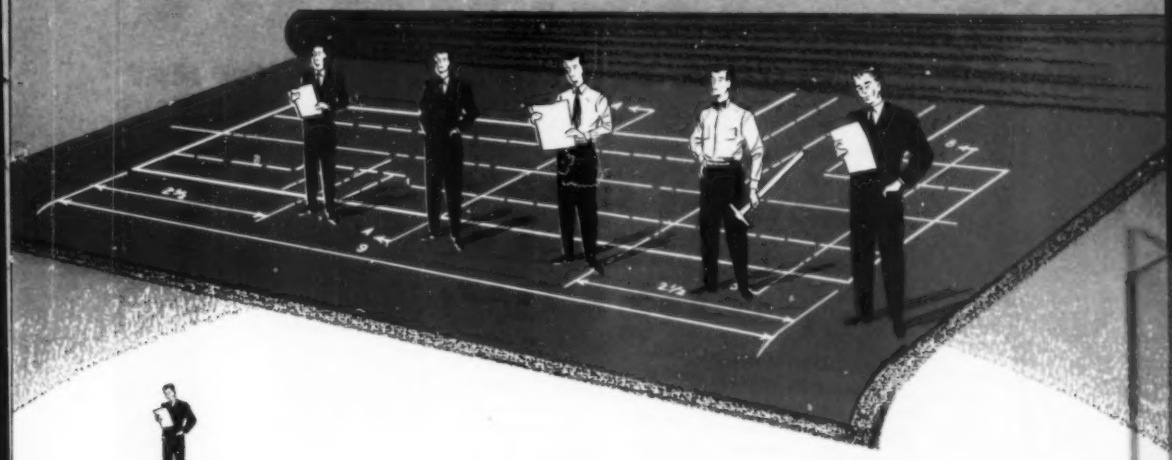
DIVISION OF NATIONAL PNEUMATIC CO., INC.

BOSTON 19, MASSACHUSETTS

"Manufacturers of fine electrical apparatus since 1875"

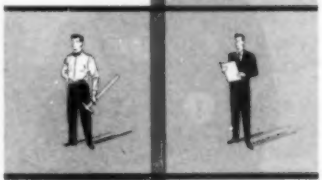
Everybody SHOULD get into the act..

For top efficiency in fastener selection



TOP MANAGEMENT—Boards of Directors, Presidents and Treasurers are guardians of company pocketbooks and protectors of the stockholders' interests. It's their job to shave production costs and boost net profits wherever possible. Choosing the right fasteners for all fabrication and assembly jobs can contribute much toward greater efficiency, and cash savings on the production line.

DESIGNER—*The Designer makes the original recommendations on fasteners. A full knowledge of the types of fasteners available, and, the jobs they are engineered to do, is essential. Lamson & Sessions will be happy to send information of this kind on request.*



ENGINEER—The Engineer is concerned with the smooth, efficient mechanical operation of the finished product. Fasteners play a vital part in his calculations. Tolerances, tensile strengths and metal characteristics are of interest to him. Lamson & Sessions' "fastener engineers" can supply this information gratis.

PRODUCTION MAN—*Speed and efficiency on the production line is of primary importance to the Production Man. There can be no time-wasting fumbling, heads must not shear or ream under power driver torque, fastener fit must be uniform. The production line is the final test of true fastener worth.*

PURCHASING AGENT—The Purchasing Agent has the choice of sources for specified fasteners. The first thought of thousands of smart "P. A.'s" is Lamson & Sessions, the "full line" manufacturer where strict Quality Control guarantees dependable fasteners.

Yes, fastener selection should be everybody's *business—from the "top brass" down. Remember, it always* pays *to pay attention to fasteners!*

The home of "quality controlled" fasteners

Lamson & Sessions

The **LAMSON & SESSIONS** Co. • General Offices: 1971 West 85th Street • Cleveland 2, Ohio

Plants at Cleveland and Kent, Ohio • Birmingham • Chicago

SILICONE

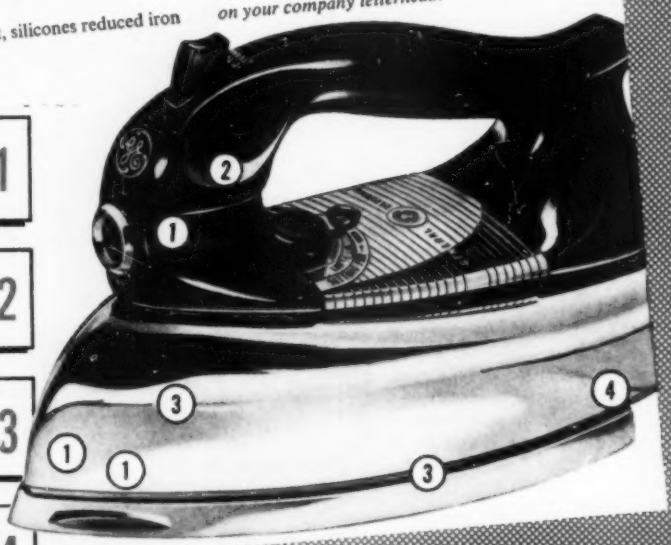
NEWS OF G-E SILICONE DEVELOPMENTS WHICH MAY

HOW G-E SILICONES ARE SAVING ONE USER $137,800 A YEAR!

Here's an example of the tremendous possibilities for production economies that General Electric silicones offer design engineers. These remarkable new materials were incorporated into a new design for an electric iron. The result? The use of four different G-E silicone products in eight specific applications is enabling the iron manufacturer to save at an annual rate of $95,800 in production costs.

Equally important, silicones reduced iron failures substantially, and this cut down on customer complaints, permitting a further annual saving of an estimated $42,000.

Are *you* taking full advantage of the cost-saving potentialities of General Electric silicones? Where can these amazing materials be used in the design of *your* product or in your manufacturing processes? *For information, write to Section O-1, General Electric Company, Waterford, New York, on your company letterhead.*



G-E silicone adhesive seals filler tube to cap, cover to soleplate and the iron tank. 1

G-E silicone rubber acts as high-temperature gasket on valve assembly. 2

G-E silicone resin eliminates corrosion beneath thermostat, stops penetration of oil and water into Calrod* unit. 3

G-E Dri-Film* water-repellent seals Calrod heating unit. 4

*Reg. U. S. Pat. Off.

GENERAL ELECTRIC

PROGRESS

HELP IMPROVE YOUR PRODUCT OR PROCESSES . . .

G-E silicone rubber gaskets used as seal on door of range.

The manufacturer of this range required a sealing gasket for the oven door which would not soften or lose resilience at high temperatures. So G-E silicone rubber, remarkable for its ability to withstand temperatures up to 550 F, was specified—and used successfully to provide resilience even under the high heat generated by the range oven.

G-E silicones make possible increased welder output with same frame size.

This welder, with conventional insulation, is rated at 180 amps., a 20 per-cent duty cycle, and 44 volts. With high-temperature-resistant G-E silicone insulation, the same-sized welder is rated 200 amps., 50 per-cent duty cycle, and 58 volts. Wound with class-A (instead of silicone) insulation, it would weigh twice as much.

ITEMS FOR ENGINEERS

Silicone Design Possibilities

by R. O. Sauer, Ph.D., Engineering Manager, Silicone Products, General Electric Co.

Silicone product types now commercially available include resins, oils, rubbers and a variety of special products useful not only to equipment manufacturers but to chemical manufacturers as well. Chemically speaking, the commercial types now are principally methyl siloxanes (entirely new to science and to commerce in the last decade) and their co-polymers with phenyl siloxanes. Theoretically a large number of other useful species are possible: some of these are to be anticipated in the next few years as the utilization of silicones increases.

Silicone products are proving useful in the design of electrical equipment such as motors, generators, capacitors and cable, especially those designed for high temperature service. Many other types of mechanical equipment are designed to use silicone rubber gaskets and seals because of high temperature stability and serviceability at low temperature. Some other applications depend on the unusual surface properties of silicones, such as their non-adhering, non-wetting, and foam-inhibiting characteristics. Many engineers are finding that silicones permit designs heretofore considered impractical.

Mallory Jacks and Plugs

for exacting specifications

Shown above are three military type Mallory jacks . . . part of the group of five types available for civilian and mobilization uses.

1. Long Frame Jacks—Threaded bushing. Mounting takes up depth, but little panel space. The spring stack-ups are mounted horizontally to the frame in a variety of spring combinations.

2. XP Long Frame Jacks—Plain, unthreaded bushing. Mounting is accomplished by a screw-nut combination. Takes up depth, but little panel space. These jacks serve the same purpose as the Mallory Standard Long Frame Jacks, but a special frame angle is employed to give greater support.

3. Junior Jacks—Threaded bushing. Mounting is parallel to panel, thus requiring less depth, but more panel space. Built with the frame supporting the spring stack at a right angle so that the jack extends only $1\frac{3}{16}$" back of the panel.

4. SC Jacks (Signal Corps Type)—Threaded bushing. Condensed size with medium panel area, minimum depth. Designed for use in all applications, but especially where limited space is important. Built to comply with JAN specifications.

5. "Grounding" Jacks No. GJ-1—Threaded bushing. Used in military aircraft to "ground" planes while refueling.

The precision and dependability of the Mallory line of jacks and plugs are the result of a unique combination of research facilities and production skill.

Specialized experience in the related fields of metallurgy, electrical contacts and electronics qualified Mallory to work in close cooperation with the Armed Services Electro Standards Agency since its inception. Mallory jacks and plugs meet a wide variety of application requirements and include a number of military types complying with JAN specifications.

Mallory jacks and plugs are available for your most exacting needs. Qualified engineering service and technical data are available on request.

Television Tuners, Special Switches, Controls and Resistors

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

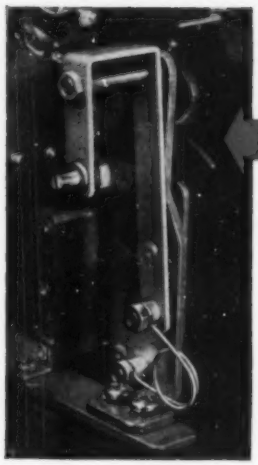
SERVING INDUSTRY WITH

Electromechanical Products
Resistors *Switches*
TV Tuners *Vibrators*

Electrochemical Products
Capacitors *Rectifiers*
Mercury Dry Batteries

Metallurgical Products
Contacts *Special Metals*
Welding Materials

5 WALDES TRUARC RINGS ELIMINATE 4 TOOLING OPERATIONS... SAVE 22½¢ PER 100 UNITS

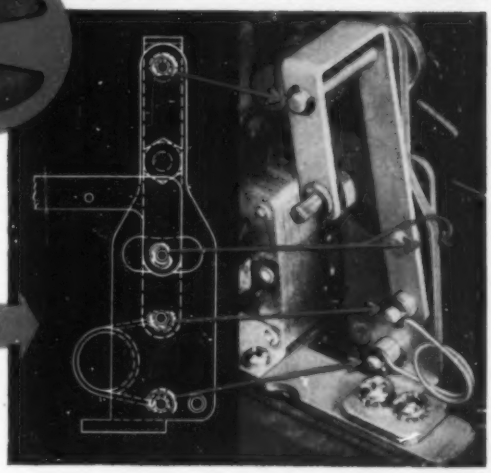


OLD WAY

Unit requires 4 hex head nuts, 4 washers, 4 shoulders, threading of 4 shafts. Clearance and end-play specifications necessary... constant maintenance.

NEW WAY

Just 5 Truarc "E" Rings set into predetermined grooves secure parts permanently. Assembly is simple, economical. No clearance specifications ...no maintenance!



5 Waldes Truarc Retaining Rings in one assembly of the Dictaphone Time-Master dictating machine brought great savings to Dictaphone Corp., Bridgeport, Conn. And this is just one of three different applications where Truarc Rings cut material, tooling and assembling costs for this product.

Redesign with Truarc Rings and you too will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc Rings are precision-engineered... quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

REDESIGN WITH 5 TRUARC "E" RINGS BRING THESE BIG SAVINGS...

Assembly time per unit using screws and washers . 24 seconds

Assembly time per unit using Truarc Rings . . . . 15 seconds

- Time saved per unit with Truarc Rings . . . . . 9 seconds
- Eliminates skilled labor milling and threading operations
- Eliminates maintenance
- **TOTAL MATERIAL AND LABOR COST SAVINGS PER 100 UNITS . . 22½¢**

SEND FOR NEW BULLETINS

WALDES TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY THE FOLLOWING PATENT NUMBERS: U. S. PAT. 2,382,949; 2,420,921; 2,411,761; 2,487,803; 2,487,802; 2,491,306 AND OTHER PATS. PEND.

Waldes Kohinoor, Inc., 47-16 Austel Place PN053
Long Island City 1, N. Y.

Please send Bulletins 6, 7 and 8—giving engineering specifications for all types of Waldes Truarc Rings.

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone_____ State_____

678

DIE CASTING

keys production to speed, accuracy and economy

CASE HISTORIES FROM MT. VERNON FILES

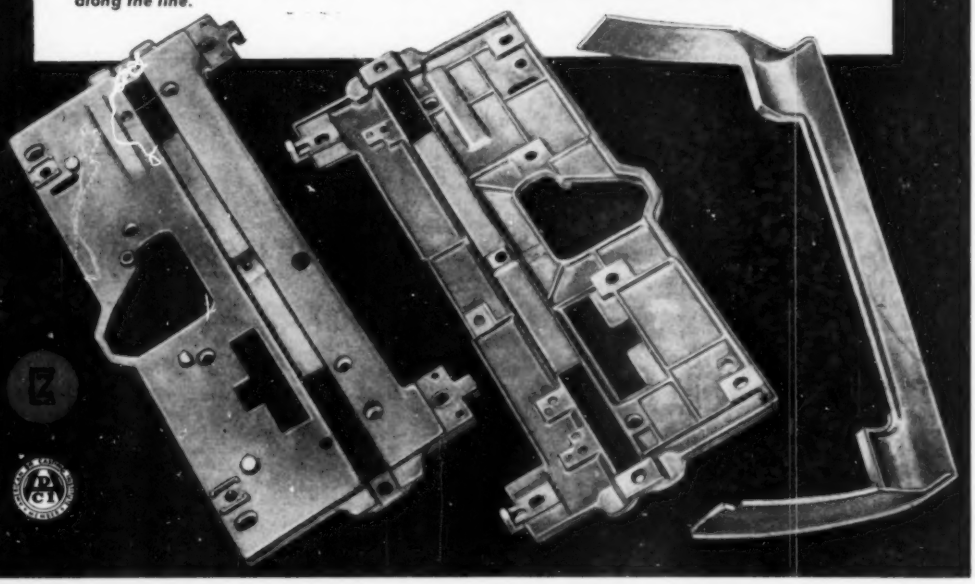
. . . keys it from A to Z — from blueprint to finished product. For die casting is industry's cost-cutting method of producing accurate parts for thousands of applications.

Take the modern typewriter, for example. Few machines of comparable size and weight have to "stand the gaff" so well, but die casting supplies important components, with outstanding strength-weight ratios, that enable it to do a thorough job—***and stay on the job indefinitely***.

Two such parts are shown here: a top plate and a keyboard guard for Smith-Corona typewriters, cast from aluminum by Mount Vernon. Each is produced instantly, as the die closes, complete in every detail—holes, slots, notches, pads, channels, studs, ribs, counterbores as required. Both have perfect contour fit. Only a negligible amount of machining is necessary. Savings are thus substantial ***all along the line***.

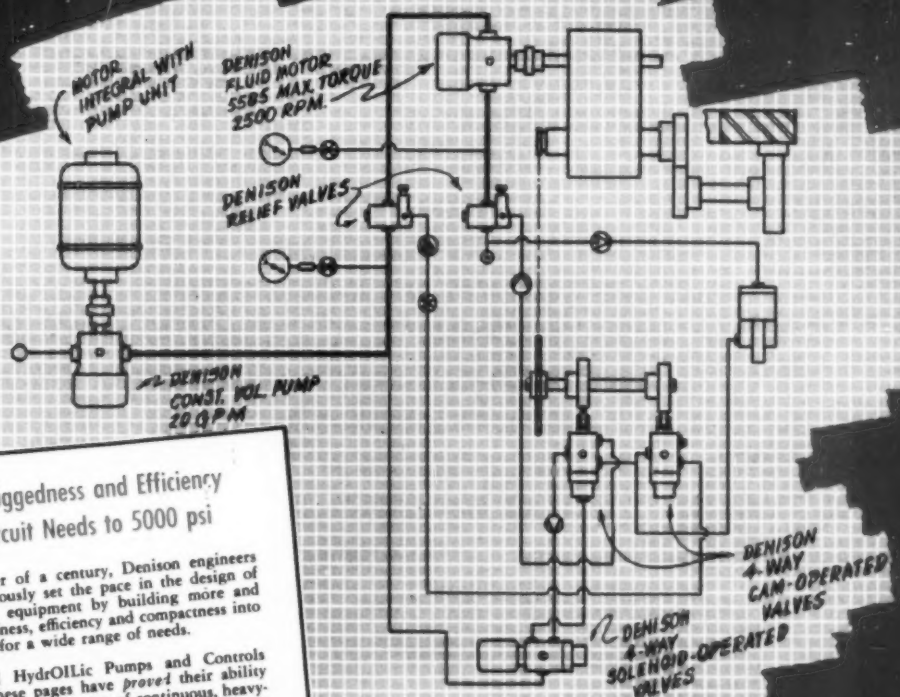
Whatever your product, simple or intricate, consult with us. We have up-to-the-minute facilities for die casting aluminum and zinc, and a vast reservoir of experience. It's very possible we can key your production to increased output and lower unit costs . . . show you the way to improved products, too.

MT. VERNON
DIE CASTING CORP.
MT VERNON NEW YORK



When hydraulics are discussed...

Denison is recommended!


MOTOR INTEGRAL WITH PUMP UNIT
DENISON FLUID MOTOR 55BS MAX. TORQUE 2500 RPM.
DENISON RELIEF VALVES
DENISON CONST. VOL. PUMP 20 G.P.M.
DENISON 4-WAY CAM-OPERATED VALVES
DENISON 4-WAY SOLENOID-OPERATED VALVES

Extra Ruggedness and Efficiency For Circuit Needs to 5000 psi

For a quarter of a century, Denison engineers have continuously set the pace in the design of oil-hydraulic equipment by building more and more ruggedness, efficiency and compactness into components for a wide range of needs.

The typical HydrOILic Pumps and Controls shown in these pages have *proved* their ability to deliver an extra measure of continuous, heavy-duty service. Many are built for circuit pressures up to 5000 psi yet cost no more than others of lower rating.

In addition, HydrOILic Controls feature space-saving compactness that helps simplify circuit design, eliminates piping through subplate mounting, and reduces costs.

Comparison will prove to you why more and more users, year after year, insist on Denison HydrOILic Pumps and Controls for circuit needs of every type.

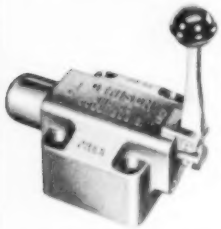
Denison

HydrOILics

DENISON High-Pressure CONTROLS

4-WAY VALVES

¾" SUBPLATE TYPE (Hand-lever control shown)

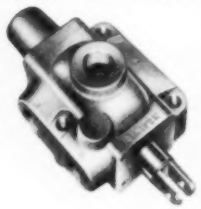


Hydraulically balanced, ruggedly designed valves for all requirements to 5000 psi. Piping connects to subplate or panel systems. Easily removed for maintenance without breaking pipe seals. Seven standard porting combinations, with seven types of controls.

Catalog VD-1

¾" THREADED BODY TYPE (Stem control shown)

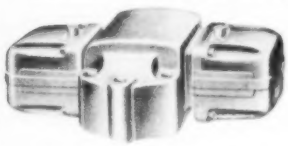
For circuit requirements to 2500 psi. Direct connections to threaded ports in valve body. Seven types of controls, for manual, mechanical, hydraulic or electrical operation of valve. Seven standard porting combinations.



Catalog VD-2

1 ½" SUBPLATE TYPE (Solenoid-operated valve shown)

Heavy-duty valves for high pressure circuits and large installations. Cam, solenoid, and hydraulic pilot operated valves in this group are offered in six types, with seven standard porting combinations.



Catalog VD-4

¼" SUBPLATE TYPE (Pilot control shown)

This group of Denison HydrOILic directional controls offers almost the same variety as the larger types illustrated above. They are available in seven standard porting combinations, with various types of operating controls.

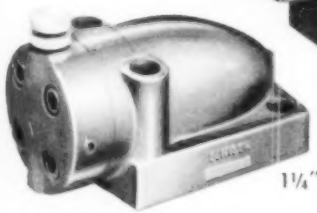
Catalog VD-3

RELIEF, SEQUENCE AND UNLOADING VALVES

¾" Threaded Body Type

1¼" Threaded Body Type

1½" Flanged Body Type



1¼" Subplate Type

Denison pressure controls feature unusual accuracy, and rugged design. Low differential between opening and closing pressures, faster action, and a pressure range to 5000 psi are a few of their many advantages.

Pressure Control Valves are offered in three pressure ranges to provide even closer control of opening and closing pressures. Threaded body types available for direct connection of piping, where desired. These valves will accurately control system pressures up to 5000 psi.

Subplate or Panel Mounted Types are also available in the ¾" size. They are more practical in high pressure systems, because pipe seals are not broken if valves are removed for cleaning or inspection. Pipe connections are made directly to the valve subplate.

Flange Connection Types. For extremely heavy usage, these valves with flange connections are recommended, to eliminate actual connection of piping to the valves. In this case, piping is connected to the flange which bolts to the valve body.

Catalog VR-2A

New Solenoid Control Eliminates Spool-Sticking

Specially Designed for High-Pressure Service and Long Cycling Periods

A Pilot-Operated, Solenoid-Controlled, 4-Way Valve. This directional control for high pressure systems eliminates spool-sticking difficulties during long holding cycles or periods of extended usage. Solenoid control operates pilot valving only. System pressure used to shift valve spool. Operates smoothly and efficiently at all pressures and for all types of circuits.

Catalog VD-1-1

PUMPS

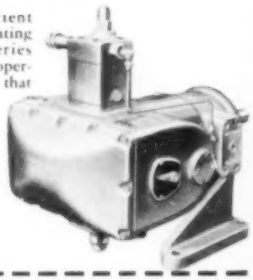
400 SERIES—CONSTANT VOLUME

A small, very compact, and economical pump of high efficiency for a wide range of circuit needs. Hydraulically balanced, axial piston design. Three models offer pressure capacities to 3000 psi, 1800 rpm, output to 9.5 gpm.

Catalog P-4-10

600, 700, 800 SERIES—VARIABLE VOLUME
Compensator Control

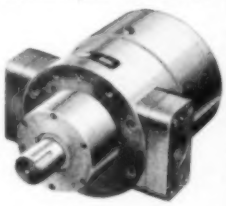
A series of highly efficient pumps with the same operating characteristics as the series above, but with a pressure-operated compensator control that automatically regulates delivery. Automatically maintains pressures in system at times of low output demand. Three sizes available.



Catalog P-4-2

600, 700, 800 SERIES—CONSTANT VOLUME

A series of rugged, heavy-duty, high pressure, high volume pumps of fixed-stroke axial piston type, for circuits developing up to 5000 psi. Three models (600, 700 and 800 series) provide deliveries up to 10, 20 and 35 gpm respectively. Flange-type pipe connections.



Catalog P-4-1

600, 700, 800 SERIES—VARIABLE VOLUME
Handwheel Control

These high pressure, high volume pumps for up to 5000 psi service feature variable volume output with handwheel control. Close regulation of maximum and minimum delivery is possible for variable requirements. Available in three sizes for maximum 10, 20 and 35 gpm output.

Catalog P-4-3

DENISON Hydraulics PUMPS AND CONTROLS

FLUID MOTORS

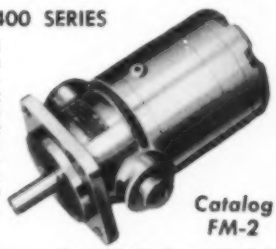
1000 SERIES

A group of unusually compact motors that withstand the constant abuse of stops and starts, reversals, and breaking actions. Operate with maximum efficiency in any position. 3 hp and 5 hp models available. Also supplied with geared heads in ratios of 3:1, 1:3, 1½:1 and 1:1½, for a wide range of operating speeds.

Catalog FM-1

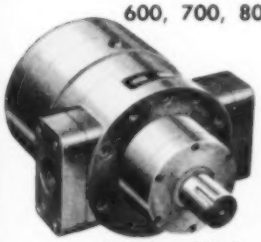
400 SERIES

A fixed-stroke axial piston motor that possesses an unusually high torque rating of 510 inch-pounds maximum — the equivalent of about 24 hp. Produces maximum 3000 rpm at pressures up to 2500 psi. Small, compact, efficient.



Catalog FM-2

600, 700, 800 SERIES



Catalog FM-3

Powerfully built high-torque, axial piston fluid motors, of compact design built in three sizes, with torque ratings that range up to 5585 inch-pounds or about 160 hp —yet even the largest is only about one foot in diameter. For circuits up to 5000 psi, they operate at maximum speeds of 2000 to 3000 rpm.

Catalog VS-1

SURGE DAMPING CONTROL Prevents Destructive Pressure Shock

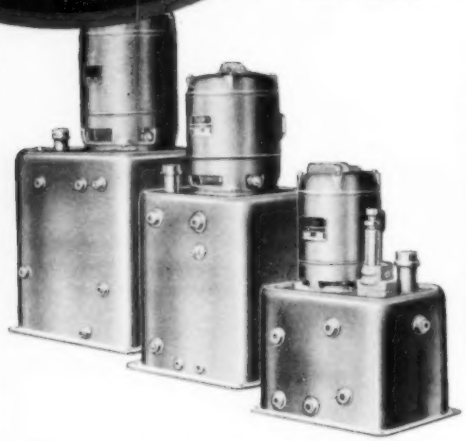
Denison's new Surge Damping Valve eliminates shock in high pressure hydraulic systems. The unit is easily installed as a standard fitting in any hydraulic circuit and does not interfere with the circuit's other functions. Proved in test setups over many months, it successfully prevents shock rather than merely absorbing hydraulic surge and consequent shock.

Operation of the Surge Damping Valve approaches uniform acceleration, assuring smooth, shockless action in the circuit, regardless of pressure used. The valve adjusts itself automatically to any working pressure, requires only a fraction of a second to act, and cannot slow down cycle time. No adjustments are necessary.

DENISON HydrOILics PUMPS AND CONTROLS

PUMPING UNITS

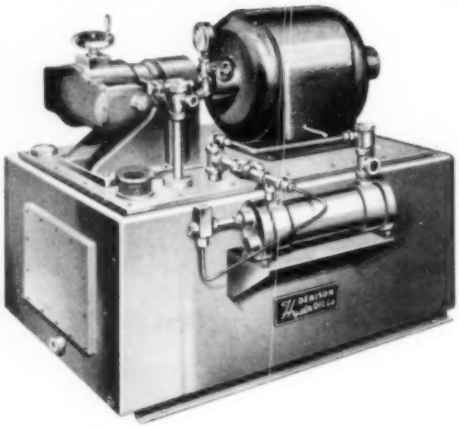
SMALL SERIES



These self-contained, vertically mounted pumping units featuring single panel assembly of all operating components, are designed for 2 gpm to 11 gpm requirements. Available in 15 models operating with high efficiency and economy in a range of from 400 to 3000 psi, they are ideal for a very wide range of industrial equipment applications. Reservoirs range from 16 to 35 gallons in capacity. Pump, relief valve and electric motor drive are all mounted as a unit assembly on the reservoir cover, and may be removed together by removing only four securing bolts. The base of each unit is formed by the oil reservoir. Water-cooled, thermostatically controlled oil coolers are available for installations where the demand on the unit is heavy.

Write for Bulletin PU-3

LARGE SERIES



The pumping unit above is one of a series of 22 new high pressure models of this design, for circuits developing pressures up to 5000 psi. Features include axial piston pumps for either constant or variable volume operations . . . volume capacities of 10, 20 and 35 gpm . . . volume control by handwheel, stem, or pressure compensation. All operating components, including electric motor, pump, relief valve, gauges and controls are mounted on the reservoir top. Reservoirs have sloping bottoms, for easy draining and cleaning. Standard 2-pass heat exchangers, with automatic thermostatic control, are available for extra heavy or continuous pumping operation. A vacuum gauge for checking suction conditions of the reservoir oil filter is also optional.

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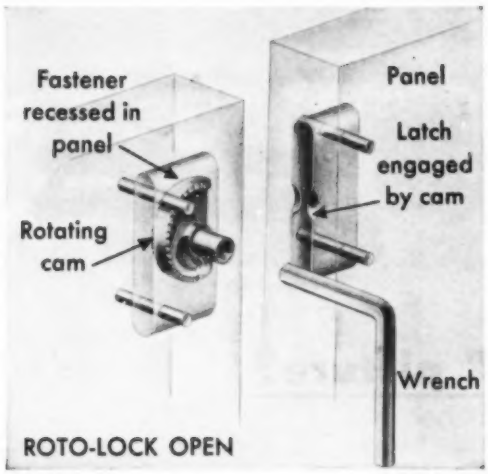
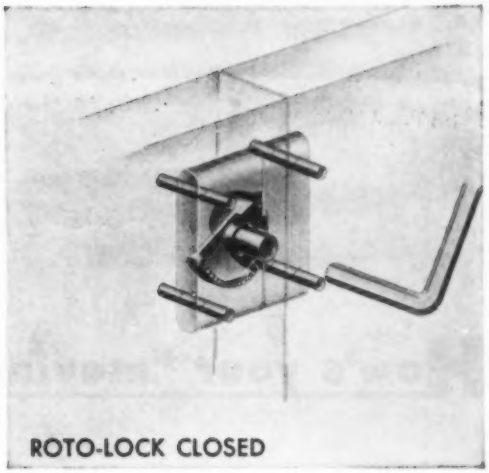
DENISON HydrOILics

THE DENISON ENGINEERING CO.
1166 Dublin Road, Columbus 16, Ohio

Litho in U.S.A.





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SIMMONS FASTENER CORPORATION
1751 North Broadway, Albany 1, New York

Simmons

SPRING-LOCK • QUICK-LOCK • ROTO-LOCK

Style E Attachment

Style A Attachment

How's your "moving" picture?

Style D Attachment

If you're designing equipment where you must provide for material movement, have you considered the flexibility—economy—efficiency of chains and attachments?

And, if you have, do you realize the possibilities for product improvement, cost reduction in the complete Chain Belt line?

In the complete Chain Belt line there is a size and type of chain . . . the *right* attachment that will exactly fit your requirements. If your machine requires exact, split-second timing, Baldwin-Rex Roller Chain and one of its many standard or special attachments will answer your need. If split-second timing is not required and low cost is important, perhaps Baldwin-Rex Double Pitch Roller Chain or a Rex Cast Chain is the answer. If corrosion is a problem, a Rex Z-Metal Cast Chain will do the job.

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For extremely heavy load, heavy-duty service, Rex

Style A Attachment

Style H Attachment

Style D Attachment

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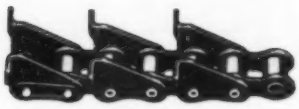
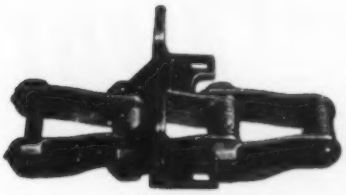
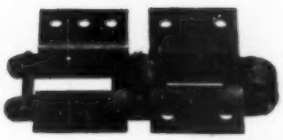


Style F Attachment



Style F Attachment

Style G Attachment



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MELTING FLUXES and AGENTS
WELDING ROD and FLUXES
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Here is a handy compilation of the latest information on Magnesium Alloys and Products. The purpose of this book is to acquaint the reader with the forms in which magnesium is manufactured and to provide information on properties, sizes, tolerances and other significant data.

If you are using magnesium now, or contemplate using it in the future, you will find this handbook of vital importance. For your copy of "Magnesium Alloys and Products" simply write to Dept. MG-65, using your company letterhead.

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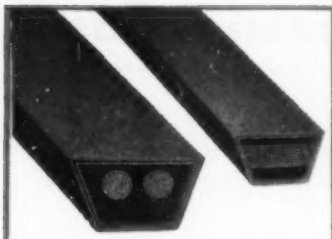

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***TEXSTEEL* SHEAVES** — Pressed steel sheaves for applications from ¼ to 25 horsepower. Light weight and rigid. 1 to 6 grooves, A or B belts. All sizes and bores available from stock.

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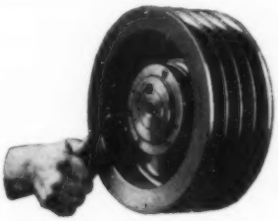
Greatest Name in V-Belt Drives



***MAGIC-GRIP* SHEAVES** — Fastest mounting sheave you can buy. Aligns easily . . . cannot shake loose. 1 to 12 grooves for A-B, B, C, and D, belts. 1 to 250 hp. Stocked in many cities for immediate delivery.

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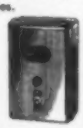

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

PUMPS — Integral motor and coupled types from ⅜ in. to 72 in. discharge and up.

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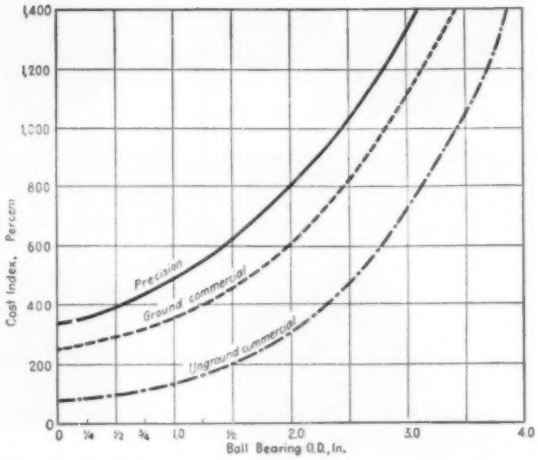

Remember these facts when you specify ball bearings:

- Schatz "Commercial" bearings come in twenty-two basic types. Metric sizes are available in a number of these types.
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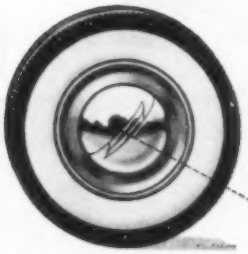

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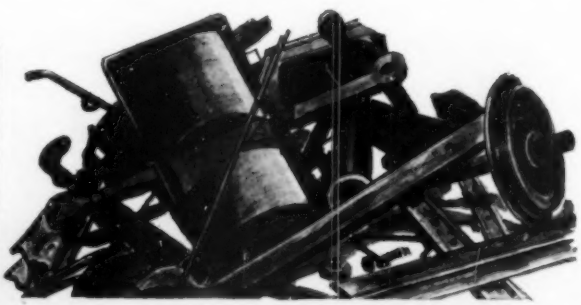

LAMINATES News

News of General Electric Plastics Laminates that can be of importance to your business.

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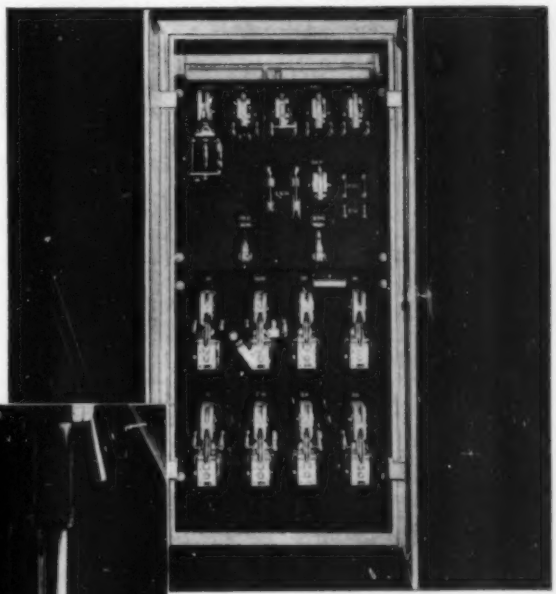

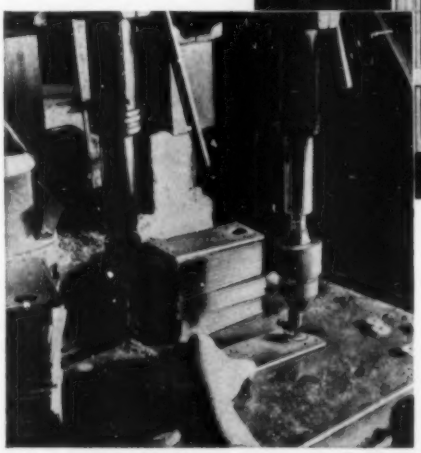

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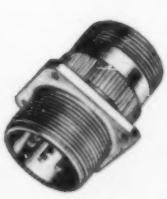
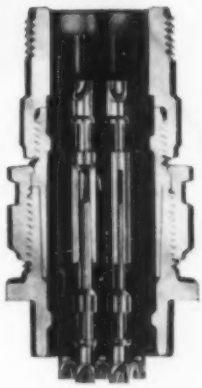
- No additional solder required

The ability to carry maximum currents with only a minimum voltage drop is an outstanding characteristic of Bendix Scinflex Electrical Connectors. This important feature is only a part of the story of Bendix success in the electrical connector field. The use of Scinflex dielectric material, an exclusive Bendix development of outstanding stability, increases resistance to flash over and creepage. In temperature extremes, from −67°F. to +275°F. performance is remarkable. Dielectric strength is never less than 300 volts per mil. All in all, no other electrical connector combines as many important exclusive features as you will find in Bendix Scinflex connectors. For higher efficiency in your electrical connectors be sure to specify Bendix Scinflex. Our sales department will gladly furnish additional information on request.



PLUS



SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.

CONTACTS
High current capacity . . . Low voltage drop.

SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High insulation resistance.

Bendix

SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK

FACTORY BRANCH OFFICES

DO NOT
LUBRICATE
Life-Line motor
PAIRED FOR PRODUCTION
Life-Linestarter

Exposed?

These two retard corrosion's bite

Splashing liquids, outdoor service, chemical fumes. You'd have to look a long time to find a motor and starter that take this kind of corrosive service as well as the matched Life-Line chemical motor and Life-Linestarter®.

The special enclosures of Life-Linestarters are extra protected to ward off corrosion. Castings are sprayed with iron-oxide, zinc-chromate primer; then, finished with aluminum lacquer. A neoprene gasket between covers seals out corrosive elements.

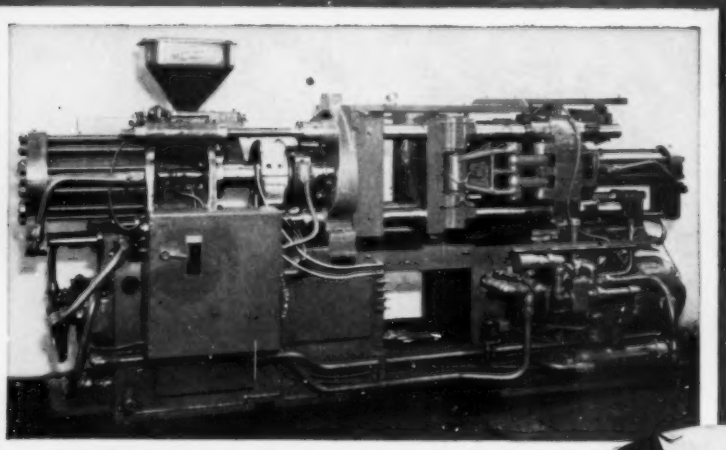
Inside, too, parts are extra protected. All steels are cadmium plated . . . contacts are pure silver . . . coil laminations, treated with protective film, then double coated with aluminum paint. These kinds of extras have made the Life-Linestarter outstanding for chemical service.

The Life-Line chemical motor has also proved itself best for chemical service, for more than one reason. Bonderized® steel frame and brackets don't give corrosion a chance . . . have outlasted conventional motors. Sealed bearings guard against acid, dirt, moisture. Windings, extra protected by multiple layers of Thermoset varnish, stand up to extreme corrosive conditions. Enclosures, too, make sure vital parts are fully protected.

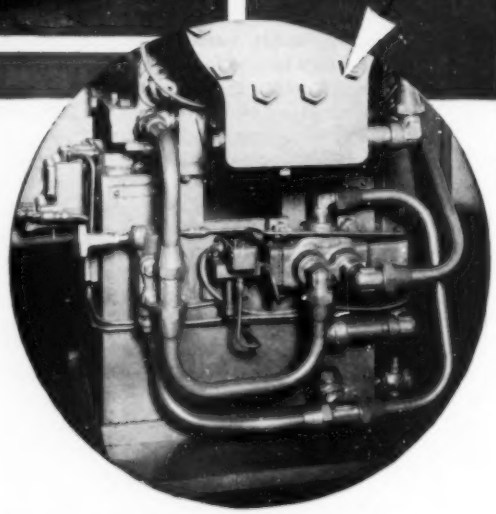
This extra protection . . . this extra life you get with Life-Line motors and Life-Linestarters is available to you at *no extra cost.* Simply specify Life-Line motors and Life-Linestarters on your next job. Ask your Westinghouse representative for complete information on this production team. He has the answers. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21627

YOU CAN BE SURE.. IF IT'S
Westinghouse
Life-Line
MOTORS and CONTROLS

To get a dependable 20,000 p.s.i. pressure this manufacturer chose National Seamless Hydraulic Tubing



*Name of manufacturer on request.



Today's plastic injection molding machines have to *produce*—day after day, often 'round the clock. The continuous duty 10D-8 shown here* exerts a 20,000 p.s.i. pressure on each 8-ounce shot of material. And since this machine is hydraulically operated, every part of the hydraulic system must be as near fool-proof as skilled design and materials engineering can make it.

The NATIONAL Seamless Hydraulic Tubing used in this equipment has to meet some unusually severe requirements. It must have great strength to resist the high internal pressures (often greatly multiplied by momentary surges as the piston starts and stops). Also, the tubing must have excellent fatigue resistance to withstand destructive vibration.

Equally important: Specially selected low carbon steel used in NATIONAL Seamless Hydraulic Tubing assures ductility to withstand severe flaring and bending operations *without splitting*. Controlled atmosphere furnaces are used to anneal the tubing, therefore it is exceptionally clean and free from scale. This is vitally important, because it prevents clogged valves due to contaminated hydraulic fluid.

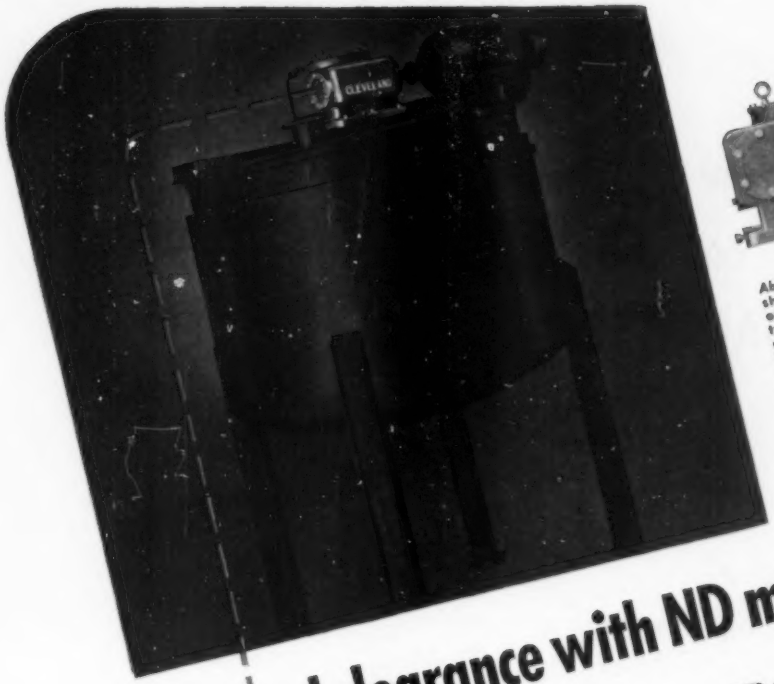
National Tube Company manufactures a complete line of hydraulic tubing, in a wide range of diameters and wall thicknesses. And our engineers will be glad to help you select just the *right* tubing to do *your* job at the *lowest possible cost*. For more information about NATIONAL Seamless Hydraulic Tubing, or any other of National's large selection of tubular products, write: National Tube Company, Tubing Specialties Division, Frick Building, Pittsburgh 19, Pennsylvania.

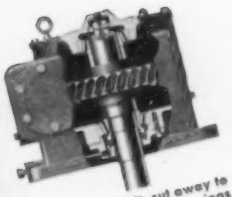
NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(Tubing Specialties Division)
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL Seamless HYDRAULIC TUBING

UNITED STATES STEEL





Above—ND unit, cut away to show tapered roller bearings on gear shaft, positive face-type oil seal, unique lubricating pump and oil drain at base of housing.

Left—1,000-gallon mixing kettle built by the Water Tube Boiler & Tank Co. for the Pyroxylin Products Co., Chicago, for use in mixing viscous lacquers.

Low overhead clearance with ND mixer drive

AN outstanding advantage of Cleveland's new ND vertical worm gear speed reducer is its low height. Installed on this 1,000 gallon mixing kettle, the ND unit adds only 16 inches to over-all height—no more than that of the motor.

The ND reducer and its companion NU unit (with drive shaft upward) are available in seven sizes each. Because of their several unique construction features, they will give efficient, trouble-free service on such equipment as agitators, mixers, overhead chain conveyors, etc., wherever vertical drives without outboard bearings are desirable.

For complete description, capacity charts and other engineering data on types ND and NU, write for our Bulletin 125. The Cleveland Worm & Gear Company, 3279 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited

CLEVELAND
Worm Gear
Speed Reducers

New *Carpenter* Slide Chart contains useful data on STAINLESS TUBING and PIPE

DESIRABLE BENDING and COILING RADII for
Carpenter STAINLESS TUBING and PIPE
THE CARPENTER STEEL COMPANY
ALLOY TUBE DIVISION • UNION, NEW JERSEY

To help you conserve Stainless and get best results from the tubing and pipe you use, Carpenter has prepared this handy slide chart. It contains data on economical tube bending radii and coil diameters for light-walled Schedule 5 pipe.

This Carpenter Slide Chart gives you—

Bending radii for Stainless Tubing
(with and without mandrels)

Coil diameters for Stainless Pipe
(Schedules 5, 10 and 40)

Technical data on
- Tensile Strength
- Rockwell Hardness
- Heat Resistance
- Thermal Conductivity, etc.

How to Get Your Copy of the New Carpenter Stainless Tubing Slide Chart

Just drop us a note on your company letterhead, and we will be glad to send you a copy of this useful slide chart. You can use it to conserve critical material by getting best possible results where you use Stainless Tubing or Pipe.

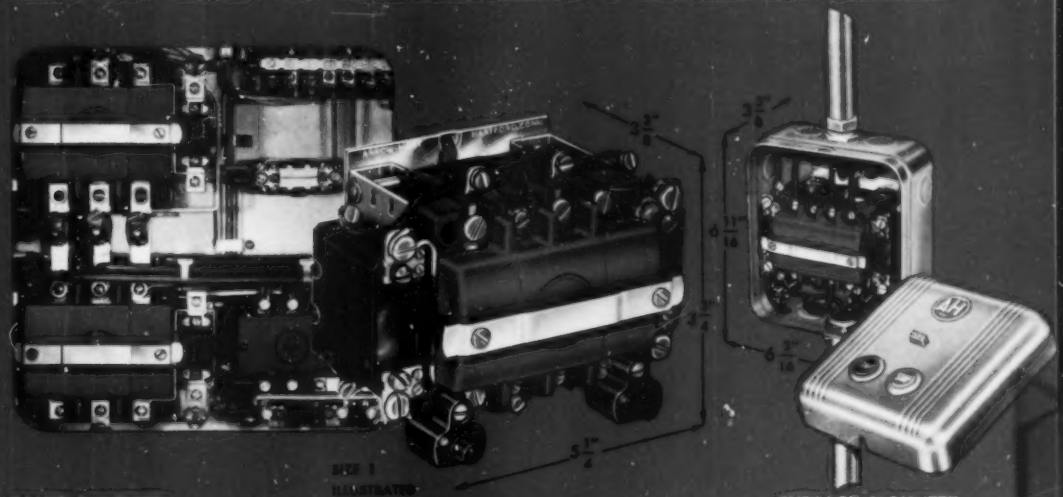
THE CARPENTER STEEL COMPANY
Alloy Tube Division, Union, N. J.
Export Department, Reading, Pa. "CARSTEELCO"

Carpenter
STAINLESS TUBING

Analysis • Tolerance • Finish

— guaranteed on every shipment

BRING OUT **BUILT-IN PERFORMANCE** OF MOTORS AND MACHINERY



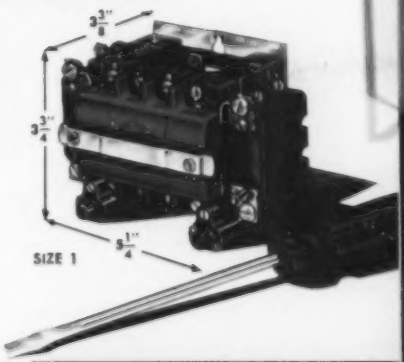
PANEL MOUNTED

SURFACE MOUNTED

NEW TYPE "RA" ARROW AH HART MAGNETIC STARTERS

JUST 1/2 THE SPACE

PLUS EASY, LOW COST MAINTENANCE



Arrow-Hart Type "RA" Magnetic Starters and Contactors are designed with easy, low cost maintenance in mind. Because the A-H starter occupies only ½ the space of conventional starters, there's more working room in the box, less space required for control panel layout. Wiring is easier, because it's straight-thru all the way. All terminals and contacts are easy to reach. Terminals are front wired. Line and load wires connect at opposite ends. The switch itself is easily installed with three mounting screws. Contact inspection or replacement is readily made by loosening two hood retaining screws. This ease of wiring and servicing is made possible by the revolutionary "RA" (Right Angle) Balanced Mechanism exclusive in Arrow-Hart starters.

BUY WITH CONFIDENCE *PROFIT BY PERFORMANCE*

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY, HARTFORD, CONN., U. S. A.

ARROW AH HART

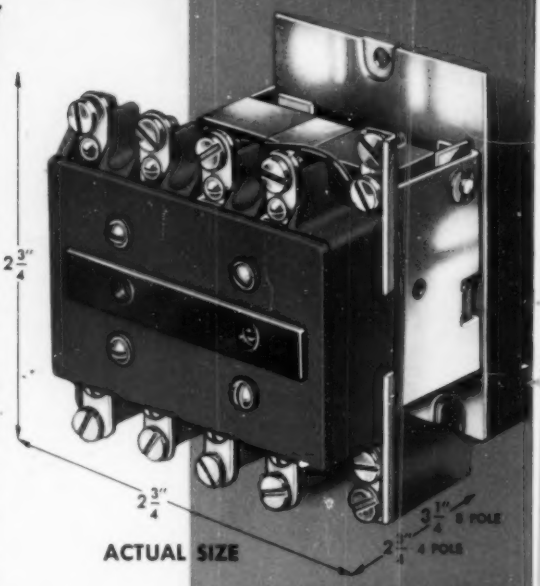
INCHES SMALLER...

EVERY INCH A CHAMPION!

NEW ARROW AH HART SIZE 00

Type "CRA" CONTACTOR

The revolutionary new Arrow-Hart Size 00 Type "CRA" Contactor measures just 2¾" x 2¾" — cuts inches off any other contactor on the market — yet is every inch a champion! Take the design: from Arrow-Hart's exclusive new "RA" (Right Angle) mechanism — the same which enabled A-H engineers to build the compact control package described on the preceding page — to the 00's ***automatic*** positive contact pressure control, this ingenious multi-pole convertible contactor results in big savings of space, work, time, money; assures you unparalleled performance throughout its long life.



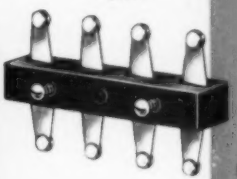
ACTUAL SIZE

ONLY 4 BASIC SECTIONS

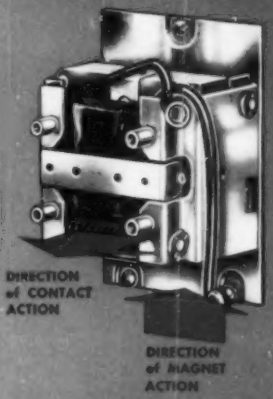
1 COVER PLATE

2 STATIONARY CONTACT BASE

3 MOVABLE CONTACT UNIT



4 FRAME with COIL-MAGNET MECHANISM ASSEMBLY



Here are just a few of its host of extra features: **Right Angle mechanism, reducing size by as much as ¾ • Ultra-functional design • Fewer components — reduced handling • No-twist no-rock frame • Compactness within own framework • Unit stability and rigidity • Foolproof, guided assembly throughout • Contacts operate in vertical position • Self-aligning contact action • Unusual ability to handle a multiplicity of circuits • Movable contact carrier • Enclosed contact chambers • All wiring in line and straight-thru • Mat-finished cover plate for terminal markings • and many more.**

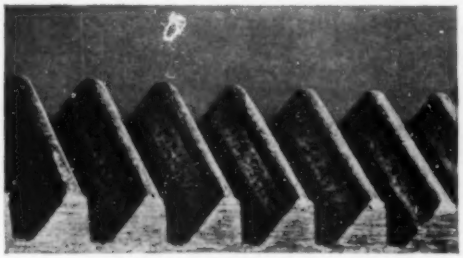
Get all the facts about the A-H Size 00 Type "CRA" Contactor, available in 2, 3 and 4 pole types. Send for Engineering Data Folder.

ARROW-HART

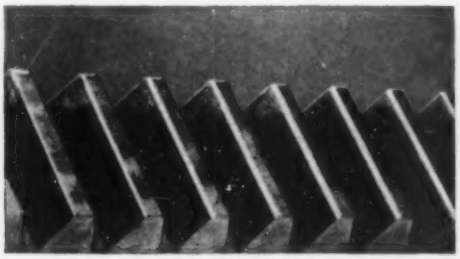
THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 HAWTHORN STREET
HARTFORD 6, CONNECTICUT, U.S.A.

Branch Warehouses: BOSTON, CHICAGO, CLEVELAND, CINCINNATI, DALLAS, DENVER, DETROIT, LOS ANGELES, NEW YORK, PHILADELPHIA, SAN FRANCISCO, SYRACUSE. In Canada: ARROW-HART & HEGEMAN (CANADA) LTD., MT. DENNIS, TORONTO.

PRINTED IN U.S.A.



This forged steel gear rack shows severe wear and pitting. The rack was made from free-machining, medium carbon, resulfurized manganese steel, corresponding in composition approximately to the A.I.S.I. C-1137 type. It was used as-forged, with a hardness of 200 Brinell, to operate against a gear made from sintered high carbon steel, copper-impregnated, with a tensile strength of 85,000 p.s.i.



This ductile iron rack, produced by The Acme Shear Company, Bridgeport 1, Conn., showed no pitting . . . after exactly the same service test as the steel rack. The only evidence of wear is a burnished appearance on edges of the teeth. This ductile iron rack had a hardness of 205 Brinell, but any hardness within the range of 150/200 proves satisfactory under similar conditions. Saving in cost is estimated at 60%, based on the low initial cost of ductile iron, and its superior machinability.

AFTER 1500 HOUR SERVICE RUN AT 50% OVERLOAD, WEAR TEST OF RACKS SHOWS NEW ENGINEERING MATERIAL

DUCTILE IRON *Superior to* FORGED STEEL

Low initial cost and superior machinability of Ductile Iron permit saving estimated at 60%

DUCTILE IRON is a cast ferrous product that combines the *process advantages* of cast iron along with many of the *product advantages* of cast steel . . .

In less than two years, ductile iron has attained wide acceptance because it offers excellent castability, high mechanical properties, and good machinability. Parts cast in ductile iron show superior pressure tightness, good elastic modulus and resistance to shock.

TYPICAL CURRENT APPLICATIONS: anvil blocks for forging hammers, wrenches, compressor heads, dies for forming rubber, pipe, cement mixer discharge rings, furnace doors, manifolds, press yokes, and many other parts.

AVAILABILITY: Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing ductile cast iron under patent licenses. Request a list of available publications on ductile iron . . . mail the coupon now.

SYMBOL OF INCO SERVICE

The International Nickel Company, Inc.
Dept. PE, 67 Wall Street,
New York 5, N. Y.
Please send me a list of publications on:

DUCTILE IRON

Name.....Title.....

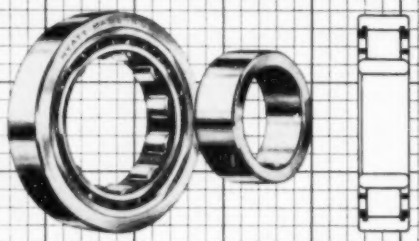
Company.....

Address.....

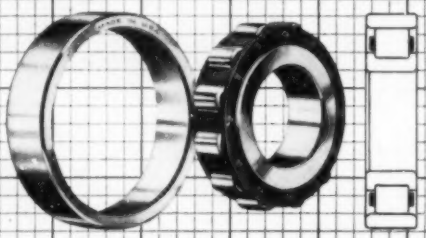
City .....State.....

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

For Radial Bearings that permit axial shaft movement HYATT HY-LOADS



A-TS TYPE
HYATT HY-LOAD



BU-Z TYPE
HYATT HY-LOAD

THE straight cylindrical race in each of the bearings pictured here permits axial freedom of the shaft to accommodate thermal expansion or other limited shaft movement. This is but one of the advantages enjoyed by designers who employ the Hyatt line of Hy-Load Roller Bearings. Others include: option of omitted race operation, complete interchangeability of parts, maximum capacity for standard dimensions—and long trouble-free life.

Full information about all types of Hyatt Hy-Load Roller Bearings is contained in Hyatt Catalog 547... a complete engineering guide to radial bearing selection and use. Write now for a copy. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

NOW!
New Space Savings
with speed reducers

A new series of concentric shaft type speed reducers has been added to the Westinghouse line of Geared Drives. This construction features straight-line mounting of speed reducer and prime mover, requiring a minimum of floor space.

Designated as "Type DB" speed reducers, these units are designed to economically transmit the inherently high speeds and efficiencies of electric motors. Power transmission efficiency averages 96%. Eight unit sizes are available over a range of 1 to 100 hp. Twelve standard gear ratios ranging from 6:25:1 to 58:3:1 are provided.

Included in these new speed reducers are the quality features common to all Westinghouse Geared Drives:

Single Helical Gears accurately hobbed on precision machines. BPT Taper Hardening produces tough, impact-resisting teeth.

Split Case Construction permits easy accessibility. Strong, tight case heavily ribbed to provide extra strength.

Ample Lubrication by simple, positive splash system for both gearing and bearings.

For more information, write for DB-3700-1 SR. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-07299

YOU CAN BE SURE... IF IT'S
Westinghouse
GEARED DRIVES

VICKERS the most complete line of hydraulic equipment for all industries

AIRCRAFT

Constant Displacement Piston Type Pumps for 3000 psi

Variable Displacement Piston Type Pump for 3000 psi

Vickers Constant Displacement Piston Type Motor for 3000 psi

Vickers pumps

Vickers Constant Displacement Piston Type Pumps are available in 24 sizes for working pressures up to 3000 psi. They have exceptionally high volumetric and over-all efficiency. Their dependability is attested by the fact that airline life in excess of 10,000 hours has been reported. Small size and extremely high horsepower-to-weight ratio are notable characteristics.

Vickers Variable Displacement Piston Type Pumps automatically deliver the volume of oil required by the hydraulic system.

Vickers hydraulic motor

Because of low inertia of moving parts, Vickers Hydraulic Motor can be started, stopped, and reversed almost instantaneously. Thus it is particularly suited as positioning device where accurate control is required. No clutches or brakes are needed as hydraulic motor can be stalled indefinitely in any position without damage. Same very high horsepower-to-weight ratio as pumps above; made in a wide variety of models for pressures to 3000 psi.

INDUSTRIAL

Vickers Single-Stage Vane Type Pump for 1000 psi

Vickers Two-Stage Vane Type Pump for 2000 psi

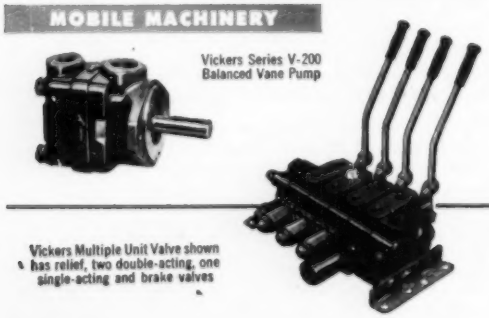
Vickers Two-Pressure, large-small volume Vane Type Pump

Vickers hydraulic pumps

"Hydraulic Balance" construction (exclusive with Vickers Vane Type Pumps) eliminates pressure-induced bearing loads with resulting longer pump life. Cartridge assembly is important to simplicity, easy inspection and minimum maintenance. The three basic types shown at left are also available built on electric motors. These pumps together with necessary valving, filters, tank, electric motor, etc. also make up Vickers Hydraulic Power Units which are self-contained power sources that result in design simplification, and savings in installation and maintenance costs on many hydraulic systems.

Vickers Variable Delivery Piston Type Pumps (not shown) provide high volumetric and over-all efficiencies at pressure up to 3000 psi.

MOBILE MACHINERY



Vickers Series V-200 Balanced Vane Pump

Vickers Multiple Unit Valve shown has relief, two double-acting, one single-acting and brake valves

Vickers vane type pumps

Exclusive "Hydraulic Balance" . . . automatic maintenance of optimum running radial and axial clearance . . . provide long life, exceptional and lasting efficiency. Easily adaptable to a wide variety of equipment. Made in a wide range of capacities with various mounting arrangements. Also available as double pumps where two independent systems are required, such as lifting and steering; consists of two pumps in tandem driven by the same shaft and in one housing.

Vickers multiple unit valves

Made up of standardized interchangeable units which can be arranged in combinations to control nearly any mobile machinery functions. Balanced valve spool construction assures easy operation and valve is unaffected by surges or back pressure. Other features: smooth and selective inching, back flow prevented, overload protection integral.

Application Engineering Offices •

ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan)
NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER • ROCKFORD • ST. LOUIS • SEATTLE
TULSA • WASHINGTON • WORCESTER

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

VICKERS hydraulics

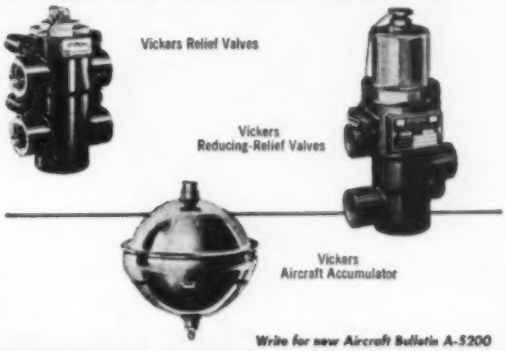
Shown here are only a few representative units from the most complete line of oil hydraulic equipment . . . the Vickers Line. Important to the designer and user of hydraulically operated machinery of all kinds, it provides greatest design latitude, many features not available elsewhere, and undivided responsibility.

More and more people are recognizing the advantages of Vickers hydraulic power and control: simplicity of installation, inherent self-lubrication, low maintenance, complete flexibility, protection against abuse and overload, etc.

Vickers Hydraulics will provide any hydraulic power and control that is commercially practical. For further information —get in touch with the nearest Vickers Application Engineering Office listed below.

Vickers pressure control valves

Vickers relief, reducing-relief and unloading valves of superior performance and reliability are available in wide range of sizes. Exclusive balanced construction eliminates pressure override. Relief valves exceed AN Standards in their small differential between cracking pressure and maximum pressure setting. Reducing-relief valve maintains constant branch circuit pressure regardless of pressure fluctuation (above setting pressure) in main supply syster



Vickers accumulators

Vickers Accumulators have the highest volume to weight ratio consistent with operating pressure. Diaphragm separates air from oil and is so constructed that it is practically impossible to choke off the oil flow on rapid discharge. Surpass AN Specifications. 3000 psi series in 5", 7½" and 10" sizes.

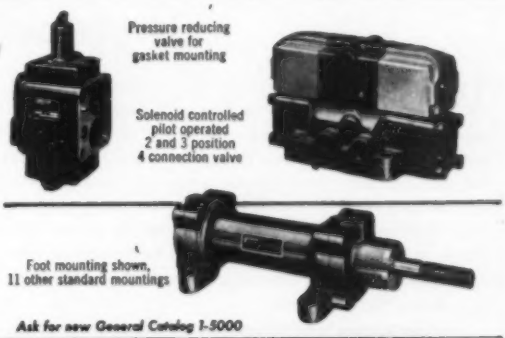
Write for new Aircraft Bulletin A-5200

Vickers control valves

Every conceivable valve requirement for controlling direction of flow in hydraulic circuits can be met; manual, hydraulic and electric operation types. Valves for limiting maximum hydraulic pressure, for controlling sequence of operations with pressure build-up, for automatically dropping pressure between cycles, and for governing many other pressure-controlled operations are available. Volume control valves also available. Sizes from ⅜" to 3", threaded, flange and gasket connections.

Vickers hydraulic cylinders

Made in many styles and sizes, they are built for longer, more satisfactory service in oil hydraulic systems. Polished rods, honed cylinders and scientifically designed packing minimize friction. Any reasonable stroke length can be furnished.



Ask for new General Catalog 1-5000

Vickers hydraulic power pack

Consists of a Vickers Vane Type Pump, overload relief valve, one or more operating valves, oil tank and filter all in one convenient compact "package." Widely adaptable for farm implements, truck tail and dump hoists, lift trucks, loaders, etc. Operating valves for actuation of either single- or double-acting cylinders can be furnished, one or more and in any combination desirable.

Vickers hydraulic power steering

Steers the heaviest vehicle at the touch of a finger. Work of steering supplied by engine-driven hydraulic pump. All road shock transmitted to frame . . . cannot get through to steering wheel. Heavy front wheel loading possible and lighter duty steering gear can be used. Automatically pressure-lubricated by hydraulic oil. Reduces driver fatigue, increases safety and productivity.

Write for New Mobile Equipment Catalog M-5100

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

1454 OAKMAN BLVD. • DETROIT 32, MICH.

4435

COST WHEN MADE FROM FORGINGS—$1.714
Cost of forging per unit. $0.4228
Production cost per unit (broached and then machined on chucking automatic). $1.2912
TOTAL COST PER UNIT— $1.714
COST WHEN MADE FROM TIMKEN TUBING—$1.47
Cost of tubing per unit. $0.293
Production cost per unit (with mill-length tubing on 4-spindle 5" capacity automatic screw machine) . . $1.177
TOTAL COST PER UNIT— $1.47

Why this sleeve costs only $1.47 instead of $1.71

WHEN made from forgings, this part cost $1.71 per piece. By switching to Timken® seamless tubing, the manufacturer was able to cut his cost down to $1.47 per piece. Here's why this saving was possible: 1. Unit for unit, Timken seamless tubing was far less expensive than forgings. 2. The mill lengths of tubing could be broached and machined on an automatic screw machine, whereas the forgings had to be broached and then machined on a chucking automatic. Actual cost figures are shown above.

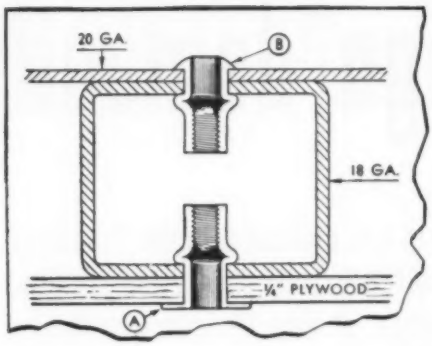
Timken tubing also offers cost advantages over bar stock, as well as forgings. With tubing you can often start right in with finish boring. The center hole is already there. Metal is conserved. Scrap loss is reduced —machining time saved.

And you get better quality too. Timken tubing gives you fine forged quality that's always uniform from tube to tube and heat to heat. For help in choosing the most economical tube size for your job, use our Tube Engineering Service. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO."

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing

NEW, BETTER WAY
to fasten plywood to steel



Trailer designers had the problem of securing ¼" plywood walls to 18 gage tubular steel sections with rivets that would not be pulled through the plywood under stress or vibrate loose in service. They found the answer in the new B. F. Goodrich Rivnut with the large washer head.

Washer-head Rivnut "A" is easier to install than either wood screws or self-tapping screws. The plywood can be countersunk so that the head of the Rivnut is flush with the plywood. Rivnuts eliminate the need for wood filler in the tubing. Brazier-head Rivnut "B" fastens either 1 or 2 sheets of 20 gage steel to the opposite side of the section.

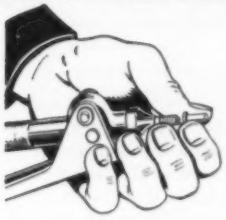
Both Rivnuts serve as blind rivets. They can also be used as nut plates for fastening trim strips and other attachments. Because installation is done by one man, from one side of the work, in a few seconds, costs for the whole operation are reduced. If you have a fastening problem, chances are there's a Rivnut that will solve it. Why not get complete information? Write The B. F. Goodrich Company, Dept. PE-51, Akron, Ohio.

THIS IS A B. F. GOODRICH RIVNUT...THIS IS HOW IT WORKS

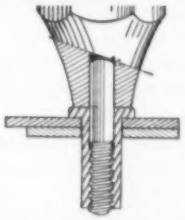
This cross-section shows the threads by which the Rivnut is threaded onto the pull-up stud of the heading tool. These threads are not injured by the heading operation and enable you to fasten *to* a Rivnut as well as *with* it.

Note counterbored portion of Rivnut in which lateral bulge is formed by pull-up action.

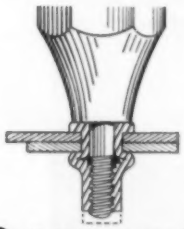
The Rivnut provides a large bearing surface, requires only a small hole, and can be installed after enameling without marring the finish.



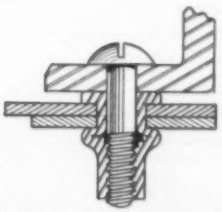
1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2. Rivnut is inserted—head firmly against work, tool at right angles to work.



3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.



4. After upset, Rivnut threads are still clean and intact, ready for screw attachment.

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

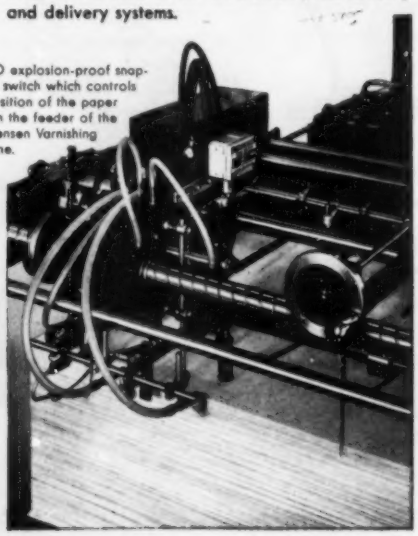
Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department PE-51, Akron, Ohio.

WHEREVER precision "good design" demands

How the Christensen Machine Company found MICRO precision switches the answer to their design problem

Among the problems confronting the Christensen Machine Company, Racine, Wisconsin in designing their Varnishing Machine for coating printed papers was the inclusion of the *exactly right* snap-action precision switch to operate safely and dependably under highly explosive atmospheric conditions.

MICRO SWITCH furnished the solution promptly in the form of an explosion-proof switch—rugged, sensitive, accurate—engineered especially for such difficult applications. At the pile feeder end of the machine, one MICRO explosion-proof switch, operating 400-600 times an hour, maintains the feeding pile at just the proper level. Two more, acting as safety switches, are located at the delivery end of the machine. Various types of MICRO precision switches are used on all Christensen press feeding and delivery systems.



MICRO explosion-proof snap-action switch which controls the position of the paper pile on the feeder of the Christensen Varnishing Machine.

MICRO Explosion-Proof Precision Switch exactly meets the requirements of this Christensen design

The MICRO Explosion-Proof Switch used on the Christensen Varnishing Machine is ideally suited for applications where a precision switch is required to operate in explosive atmospheres.

It is a rugged heavy-duty precision switch designed for use as limits, saf·ties and interlocks in such hazardous atmospheres as are found in paint, varnish, starch, pyroxylin and chemical plants, flour mills and oil refineries.

The switch used by Christensen and also pictured on the right hand page is enclosed in a metal housing. The radius-tipped push-rod plunger moves in a long hexagonal bushing. A stop ring near the plunger tip limits overtravel and permits a steady load of as much as 100 pounds on the plunger without injury to the switching element. MICRO Explosion-Proof Switches are also available with rotary roller arm actuators adjustable to any position through 360°.

These MICRO Explosion-Proof Switches are Underwriters' Laboratories listed for hazardous atmospheres Class I, Groups C and D, and Class II, Group G. This includes vapors of ethyl ether, gasoline, petroleum, naphtha, alcohol, acetone, lacquer solvent, natural gas and atmosphere charged with grain dust.

Send for "Uses Unlimited"

You will find it full of live, first hand information on the newest developments in the MICRO line and factual data on uses design engineers are finding for these precise snap-action switches. Write for your copy today.

A DIVISION OF

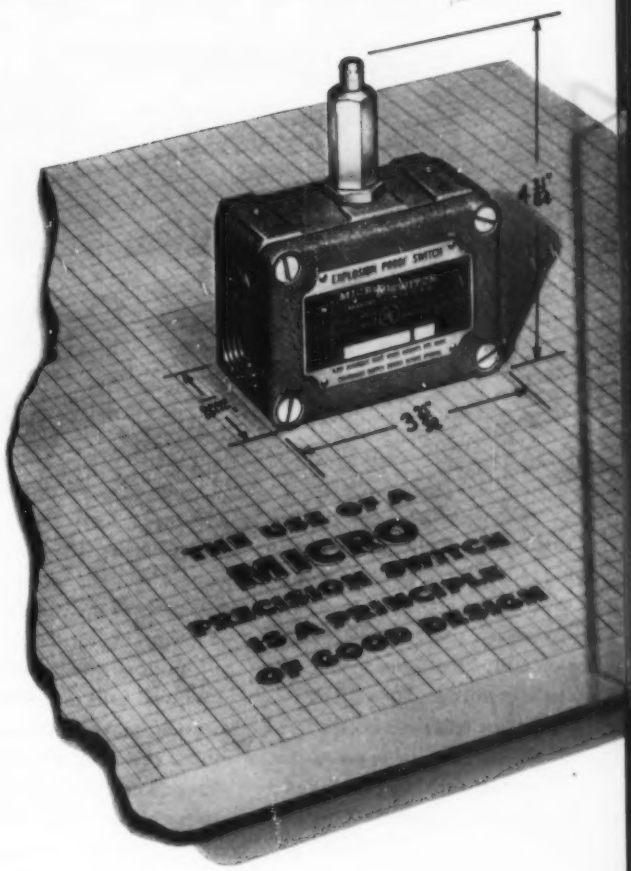
switches are required, MICRO Precision Switches!

MICRO snap-action precision switches have met successfully the requirements of more than 4600 different applications in every phase of industry.

Where inches and ounces count, their small size and light weight is a prime factor. Their rugged housings and long life make them ideal for equipment where the going is rough. Their precise, accurate and sensitive operation meets the demands of delicately adjusted controls. MICRO SWITCH has, or can supply you with, the snap-action precision switch to meet exactly your design requirement.

Among the 4600 applications where "the use of MICRO precision switches has proved a principle of good design" are their use as dependable components of equipment for packaging products, making change, bottling fluids, gauging dimensions, controlling temperature, operating aircraft controls, heating water, dispensing drinks, controlling electronic tubes, operating relays, steering ships . . . and as limits and interlocks for machine tools.

Consultation with MICRO SWITCH engineers can save you time and money, expedite the development of any product calling for precise snap-action switches.



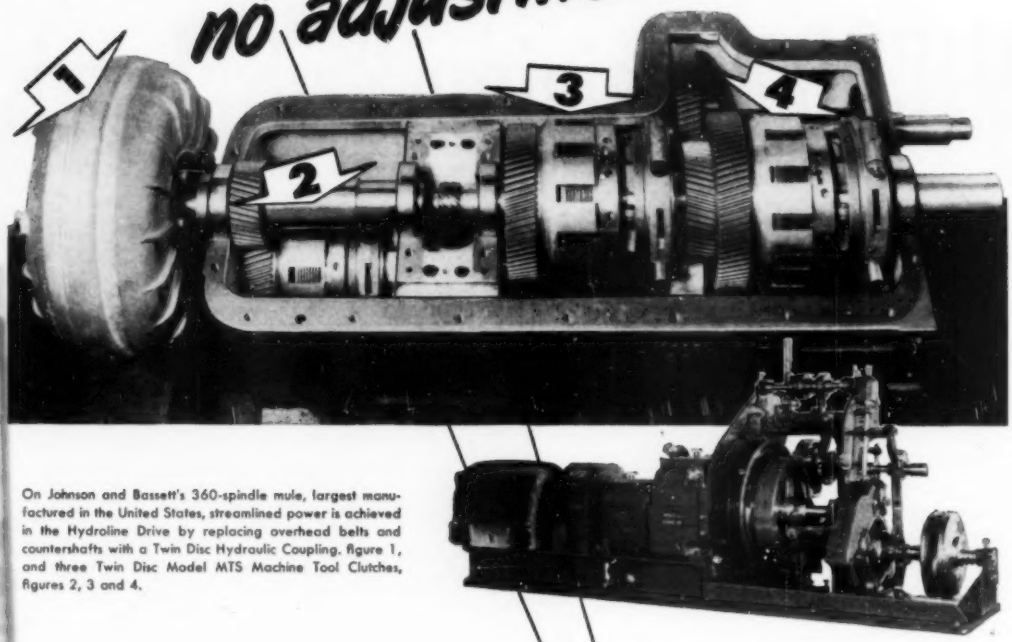
MICRO SWITCH

MICRO SWITCH
FREEPORT, ILLINOIS, U.S.A.

FREEPORT, ILLINOIS

MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

No belts to slip... no adjustments to make



On Johnson and Bassett's 360-spindle mule, largest manufactured in the United States, streamlined power is achieved in the Hydroline Drive by replacing overhead belts and countershafts with a Twin Disc Hydraulic Coupling, figure 1, and three Twin Disc Model MTS Machine Tool Clutches, figures 2, 3 and 4.

Overhead belts and countershafts, with their multiplicity of hazard, operating and maintenance problems, are replaced with a compact, streamlined transmission unit in the Johnson and Bassett HYDROLINE DRIVE Mule.

And one result has been a 10 to 20 per cent *increase in production.*

The transmission includes a Twin Disc Hydraulic Coupling and three Twin Disc Machine Tool Clutches. The fluid coupling assures smooth, shock-free starting, permits the motor to come up to working torque fast to maintain uniform spindle speeds.

With no belts to slip, no adjustments to make for extended periods, the whole operation is cleaner, safer. And smooth power assures higher quality yarns, from the coarsest to the finest.

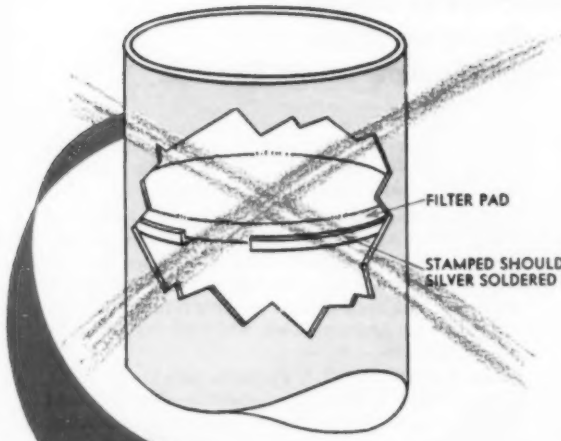
Why not investigate Twin Disc Hydraulic Couplings with their *smooth* power-flow performance. Investigate, too, Twin Disc Machine Tool Clutches with instant release and high torque capacity in the most compact space. It will pay you to obtain complete information. Write today for engineering bulletins.

Clutches & Hydraulic Drives

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA



Kid Reliance Says

"Reliance Rings are a more efficient and economical fastening device."

THIS IS A BETTER WAY

the problem: to locate a filter pad inside a tube so it can be removed and replaced.

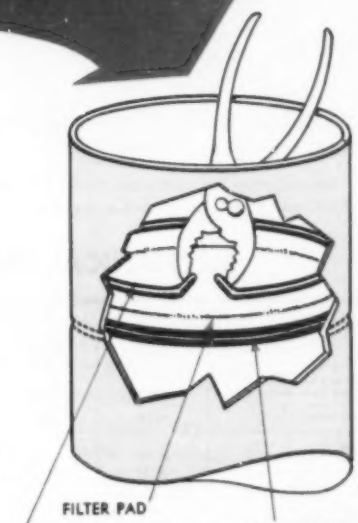
the old way: a stamped shoulder was silver-soldered inside the tube—a tedious, expensive operation, even when high-frequency heating was used. The fixed shoulder also made cleaning difficult.

with Reliance Rings: a shallow depression is rolled into the tube wall. A snug-fitting Reliance Ring is then forced into the tube until its progress is stopped by this depression. This ring supports the filter.

The procedure is greatly simplified. Soldering is eliminated. The ring is removed easily to facilitate cleaning.

another advantage: a second Reliance Ring bears against the filter pad, the tension of this ring holding the pad in place against back pressure. Ends of this ring are turned in so it can easily be removed for filter replacement.

If your production involves positioning or retaining anything in a bore or on a shaft—even under heavy thrust loads—Reliance Rings can probably simplify the operation and reduce its cost. Consult your nearest Eaton-Reliance office for detailed information on Reliance Rings.


FILTER PAD
SECOND RELIANCE RING HOLDS FILTER IN PLACE
RELIANCE RING RESTING ON ROLLED DEPRESSION IN TUBE WALL SUPPORTS FILTER PAD

EATON

EATON MANUFACTURING COMPANY

RELIANCE RINGS

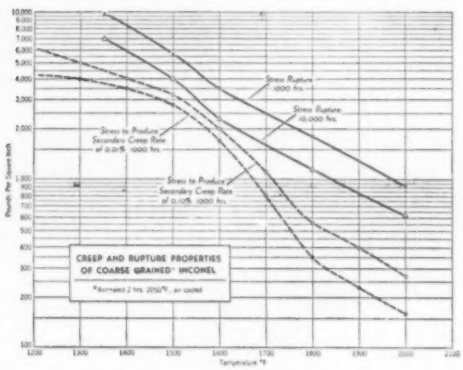
RELIANCE DIVISION, MASSILLON, OHIO

Sales Offices: New York, Cleveland, Detroit, Chicago, St. Louis, San Francisco, Montreal

INCONEL

A Structurally Stable Heat-Resisting Alloy For High-Temperature Service

INCONEL®, a wrought nickel-chromium-iron alloy, is noted for its strength and resistance to oxidation at high temperatures. A structurally stable alloy, INCONEL does not lose its toughness or ductility, due to internal structural changes, even after long exposure to high temperatures. It is particularly useful for service involving high temperatures, cyclic heating and cooling, and service where large temperature gradients exist.


Stress Rupture 1000 hrs.
Stress Rupture 10,000 hrs.
Stress to Produce Secondary Creep Rate of 0.01% 1000 hrs.
Stress to Produce Secondary Creep Rate of 0.001% 1000 hrs.
CREEP AND RUPTURE PROPERTIES OF COARSE GRAINED* INCONEL
*Annealed 2 hrs. 2050°F., air cooled
Pounds Per Square Inch
Temperature °F

Creep- and stress-rupture data for INCONEL up to 2000°F are outlined in this chart.

Room temperature mechanical property ranges of INCONEL mill forms are shown in the following table:

Impact Strength. Charpy tests reveal impact strength ranging from 187 ft.-lb. at sub-zero temperatures to 154 ft.-lb. at 1400°F.

Spring Properties. INCONEL is used regularly for springs at temperatures of 500 to 600°F, because of its resistance to relaxation or load loss in this range.

Low-Temperature Properties. INCONEL gives excellent performance in sub-zero temperatures. Strength factors *increase* considerably in this range, *without* appreciable loss of ductility or toughness.

Corrosion Resistance. The chromium content of INCONEL raises its oxidation resistance considerably above that of pure nickel, while at the same time its high nickel content provides high corrosion resistance under reducing conditions. It is highly resistant to fresh and salt water, exhaust gases, and most organic acids and compounds.

Fabrication. INCONEL is workable, both hot and cold. It is machinable, though high-speed steel tools should be used. It can be joined by the usual welding, brazing, and soldering processes common to industry.

Applications. INCONEL is used for manifolds, collector rings, heaters, lock wires, gaskets, jet blankets and combustion liners, thermo-couple coverings, domes and transition units in jet-propelled aircraft.

Forms Supplied. INCONEL is produced in the usual mill forms—billets, rods, rounds, flats, hexagons, sheet and strip, bars, tubing, wire, and a new T section. It is also produced in sand, centrifugal and precision castings.

FOR FURTHER INFORMATION

ENGINEERING PROPERTIES OF INCONEL is a Technical Bulletin on Inconel that gives a full, factual story. It is punched for ring book insertion, and will be sent, free, on request for *Technical Bulletin T-7*. And for technical help on specific high-temperature metal problems, write fully to INCO'S Technical Service Section.

MECHANICAL PROPERTY RANGES OF INCONEL

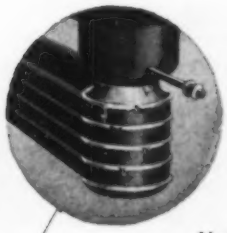
Form and Condition	Tensile Properties				Hardness		Impact Strength Charpy U-Notch ft.-lb.
	Tensile Strength 1000 psi	Yield Strength (0.2% offset) 1000 psi	Elongation in 2 in. %	Reduction of area %	Brinell 3000 Kg	Rockwell	
Rod and Bar							
Cold Drawn Annealed	80-100	25-50	55-35	70-60	120-170	65-85B	230
As-Drawn	105-150	80-125	30-10	60-30	180-290	90B-30C	151
Hot-Rolled	80-120	25-90	55-30	70-50	120-210	65-95	191-230
Wire							
Cold Drawn Annealed	80-105	25-50	50-25	—	—	—	—
Regular temper	130-175	115-165	12-3	—	—	—	—
Spring	165-185	150-175	10-2	—	—	—	—
Sheet							
Cold Rolled Annealed	80-100	30-45	55-35	—	—	88B max.	—
Deep Drawing & Spinning quality	80-100	30-45	55-40	—	—	65-80B	—
Strip							
Annealed	80-100	30-45	55-35	—	—	84B max.	—
Spring temper	145-170	120-160	10-2	—	—	30C min.	—

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
NICKEL INCO ALLOYS

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL
DURANICKEL® • INCONEL® • INCONEL "X"®.

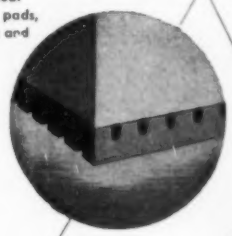
Weather resistance
For example, pneumatic compressor hose made with a neoprene cover has unexcelled resistance to deterioration from sunlight and aging.



Oil and grease resistance
Products such as neoprene V-belts won't fail prematurely because they resist attack from oils, grease and most chemicals.

Abrasion resistance
Neoprene products are tough and won't cut, chip or scuff easily. Mining cables made with neoprene are extremely durable, and will not propagate flame.

Low compression set
Neoprene can be compounded to resist permanent distortion . . . is the ideal material for vibration pads, motor mounts, gaskets and seals.



Heat resistance
Heat won't soften neoprene. That's why it's used for heat resistant belts like these for conveying hot, oil-treated coke.

ALL these properties and many others make NEOPRENE useful in a wide variety of products

For the most difficult jobs, neoprene's outstanding properties can be specially combined to meet exacting requirements. Where excessive heat is a problem, neoprene can be compounded to supply superior heat resistance. The same is true of resistance to abrasion, grease and oils, weather, flame . . . and so on through neoprene's full range of exceptional characteristics. That's why today, so many designers specify Du Pont neoprene for their top-quality products. Your rubber goods manufacturer can formulate neoprene with a combination of properties to add greater efficiency, lower maintenance and longer life to your product.

DU PONT

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

NEOPRENE

The rubber made by Du Pont since 1932

FREE! **THE NEOPRENE NOTEBOOK**

Full of interesting stories. New, unusual applications of neoprene to build new products . . . improve old products . . . reduce maintenance costs.

E. I. du Pont de Nemours & Co. (Inc.)
Rubber Chemicals Div. B-5, Wilmington 98, Del.

Please send me free issues of **The Neoprene Notebook.**

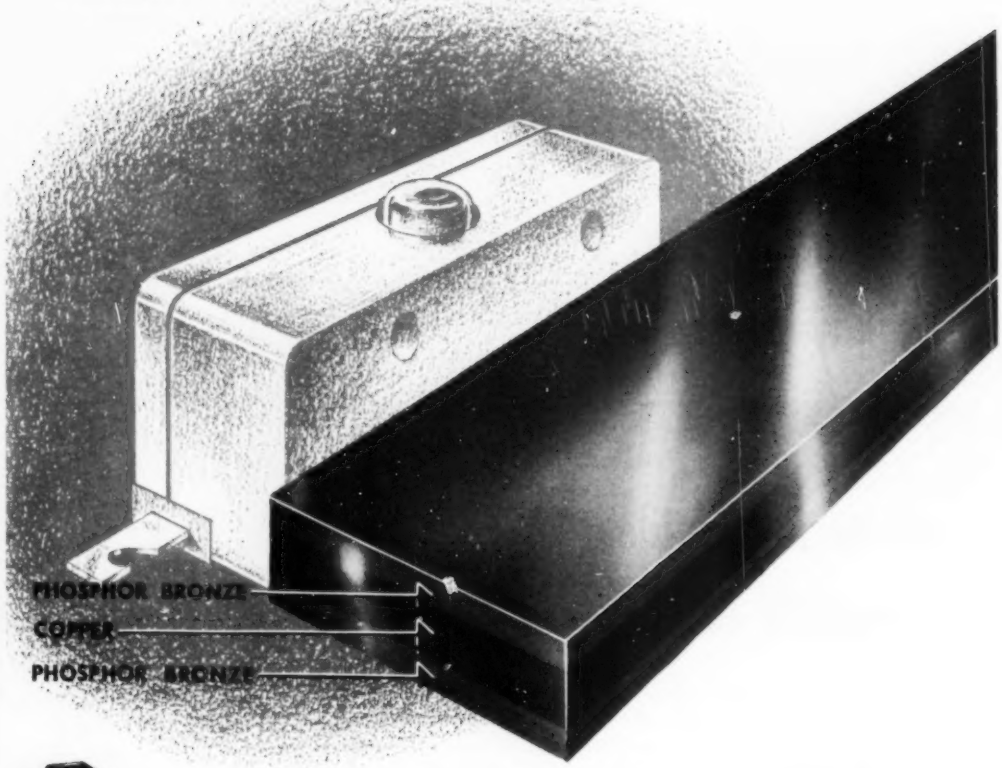
*Name*_____
*Position*_____
*Firm*_____
*Address*_____

PROBLEM:

How to Get Better Electrical Conductivity in a Switch Spring

GENERAL PLATE:

Provided the Solution with "BRONCO", a Composite Metal



A well-known manufacturer of small switches needed high electrical conductivity in a spring. Solid phosphor bronze would be too thick or would heat up too much.

The problem was presented to General Plate engineers who quickly provided the solution with "BRONCO" strip, a double clad metal — phosphor bronze on copper. The desired electrical conductivity was obtained, the spring size was maintained.

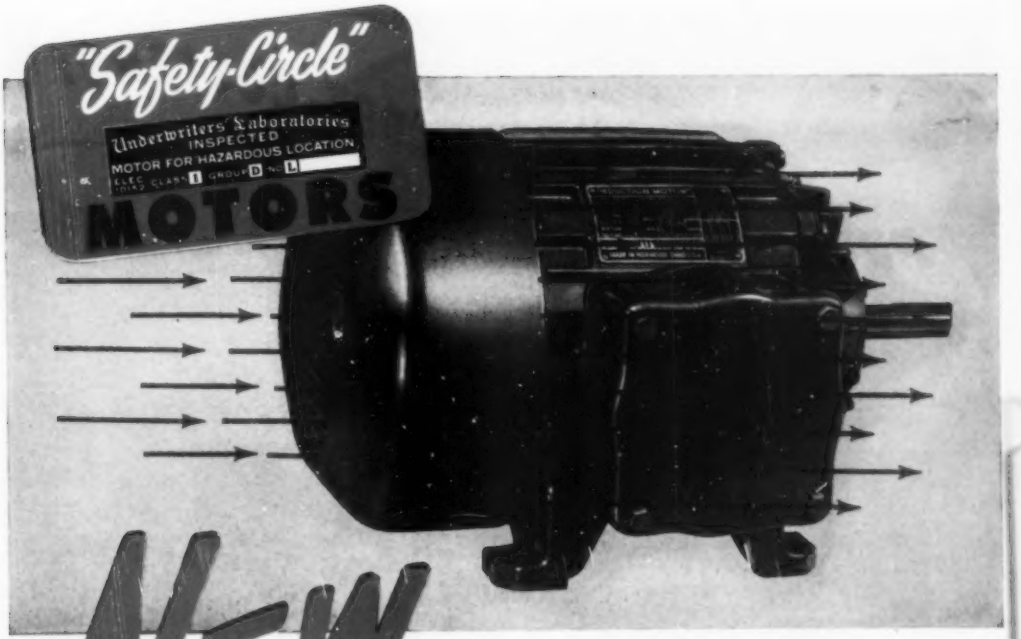
No matter what your metal problem, it will pay you to consult with General Plate. Their vast experience in cladding precious to base metals or base to base metals can overcome your problems . . . often reduce costs.

General Plate Products include . . . Precious metals clad to base metals, Base metals clad to base metals, Alcuplate (copper and aluminum), Silver Solders, Composite contacts, buttons and rivets, Platinum fabrication and refining, Age-hardenable #720 Manganese Alloy. Write for information.

Have You a Composite Metal Problem?
General Plate can solve it for you

GENERAL PLATE
Division of Metals & Controls Corporation
105 FOREST STREET, ATTLEBORO, MASS.

50 Church St., New York, N. Y. • 4326 N. Elston Ave., Chicago, Ill. • 757 W. Third St., Mansfield, Ohio • Detroit, Mich. • Los Angeles, Calif.



NEW Easy to Clean Resists Corrosion

HERE IS A NEW EXPLOSION-PROOF MOTOR that will solve many of your design problems. You can place it anywhere you please because it almost never needs cleaning or routine maintenance. There are no corners, pockets or hidden air passages to collect dirt. Fan and housing design keep cooling air flow tight against the yoke so dirt does not accumulate. When cleaning is required, simply blow the dirt off the outside of the motor with an air hose.

Pre-lubricated Bearings

Bearings are pre-lubricated at the factory and should need no attention for years. Extra rigidity of the cast iron frame holds bearings in alignment under all operating conditions.

Corrosion Resistant

Major external parts are of cast-iron with consequent inherent corrosion resistance of this familiar metal. No extra treatment is required and cast-iron's corrosion resistance won't chip off.

Get All The Facts

The new *Safety Circle* Type APZZ explosion-proof motor is built in Nema standard frame sizes from 224* to 505. Call your nearest Allis-Chalmers Authorized Dealer or Sales Office or write Allis-Chalmers, Milwaukee 1, Wisconsin for Bulletin 51B6144. A-3342

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

Safety Circle, Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

*Similar design non-ventilated motors, Type APKK, also available in frames 203 to 224 inclusive.

Custom-made SYLPHON STAINLESS STEEL BELLOWS ASSEMBLIES

WHEREVER YOU USE stainless steel bellows assemblies, in thermostatic devices, pressure controls, hydraulic mechanisms, valves, etc.—you can make savings when we make them for you.

Tick them off! No production problems for you. We take over the complete job. No question about accuracy. We make them to your exact specifications. They're built by skilled personnel—backed by half-a-century of experience in this specialized field.

More savings for you. We have the facilities and the special equipment that means production for you on schedule—in any volume.

You may need a stainless steel (or other metal) assembly that is similar to one we have already produced. Or you may need a special type. Whatever you require, our technical staff will work with you on design and development—see that you get *exactly* what you need.

Find out how you can save in many ways. Write for information. And ask for that gold mine of ideas—Catalog JP-1200.

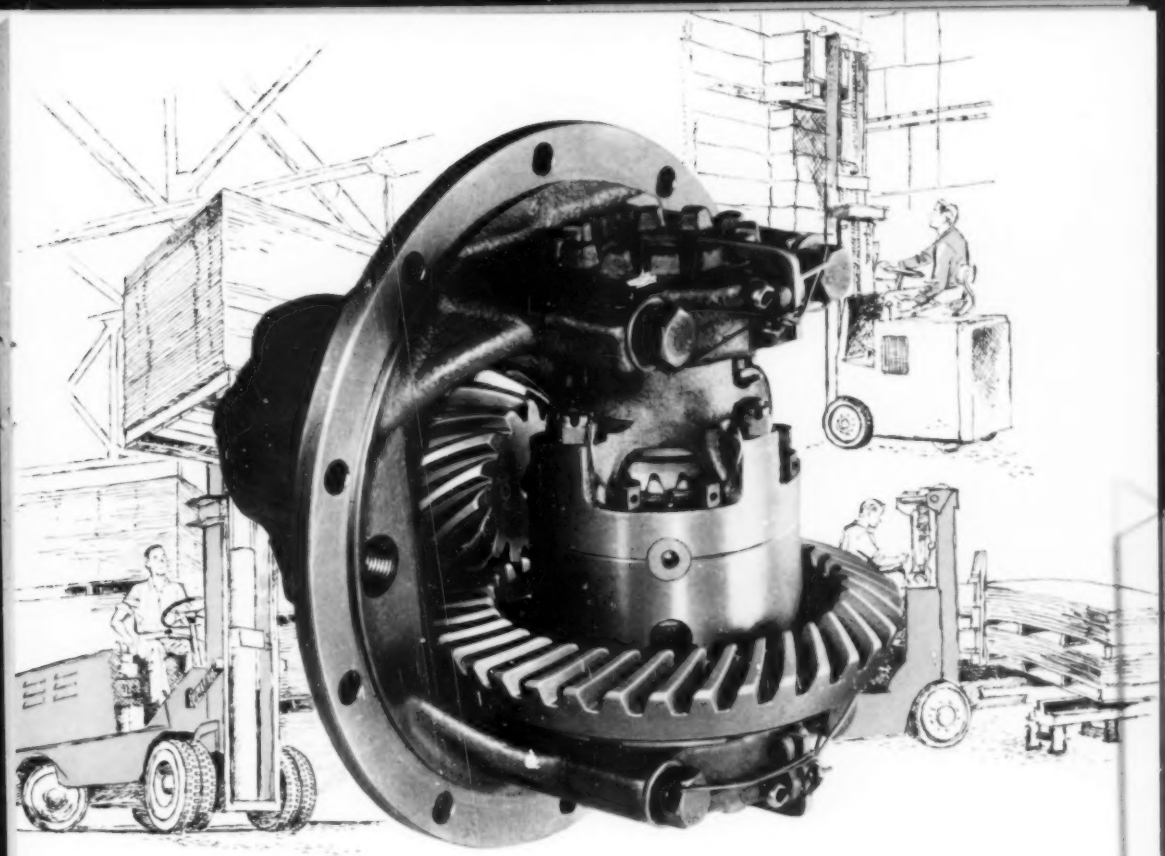
TEMPERATURE CONTROLS

FULTON SYLPHON
DIVISION
Knoxville 4, Tenn.

Robertshaw-Fulton
CONTROLS COMPANY

BELLOWS ASSEMBLIES • BELLOWS DEVICES

BRIDGEPORT THERMOSTAT
DIVISION
Bridgeport 1, Conn.



Muscle for America's favorite WORK HORSE

A great development of all-round usefulness to American industry is the fork lift-truck. Today, these swift, efficient machines are pacing the flow of materials in almost every American industry.

In thousands of fork lift-trucks you'll find transmission and differential assemblies made by Automotive Gear Works, Inc. Few gears of any type are exposed to such constant, heavy-duty use. This is particularly true now with increased three-shift production; with trucks working on every kind of flooring and terrain, rough or smooth, indoors or outdoors; and often handling loads greater than recommended capacities. Even under these circumstances "Double Diamonds" are providing dependable, trouble-free "muscle" for hosts of these hustling work horses.

The fact that "Double Diamond" Gears are preferred by leading fork lift-truck manufacturers may suggest the advisability of calling in a "Double Diamond" engineer when you next need gears of the many types we manufacture.

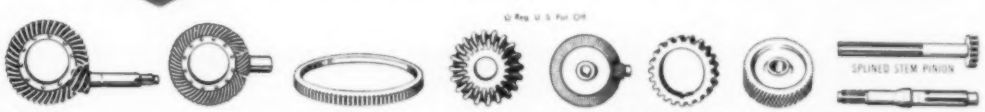
DOUBLE DIAMOND GEARS
TRADE MARK

AUTOMOTIVE GEAR WORKS, INC.

RICHMOND, INDIANA

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS

Reg. U. S. Pat. Off.



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...INDIANA *High-Energy* PERMANENT MAGNETS

Need permanent magnets?
Call in INDIANA, world's *largest* producer!
INDIANA makes nothing but permanent magnets . . .
all materials, all types, all sizes . . .
and renders *completely unified service*
from magnet design to delivery.
At INDIANA, permanent magnets get full-time attention
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SAVE TIME AND MONEY

Whether you want reliable "use" information
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you'll find the *whole organization* ready and willing
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The industry's greatest diversification
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when you call in INDIANA,
sole makers of Hyflux Alnico V . . .
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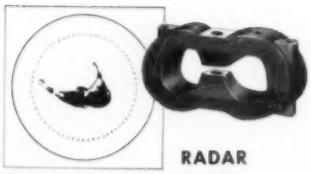
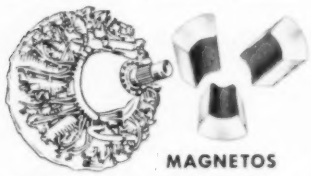


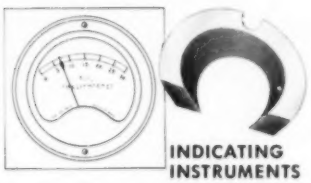
RADAR

Stability, inherent in permanent magnets, makes magnetron tubes practical.



MAGNETOS

Reliability of permanent magnets makes magnetos the most dependable form of ignition.

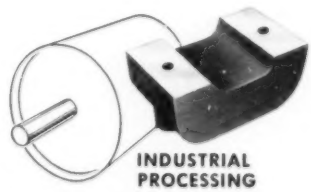


INDICATING INSTRUMENTS

Permanent magnets are essential to hundreds of types of instruments.

COMMUNICATIONS

Trouble-free permanent magnets permit unattended operation indefinitely.



INDUSTRIAL PROCESSING

Versatility of permanent magnets is continually improving processing. Illustrated: separator pulley for removing tramp iron from bulk material.

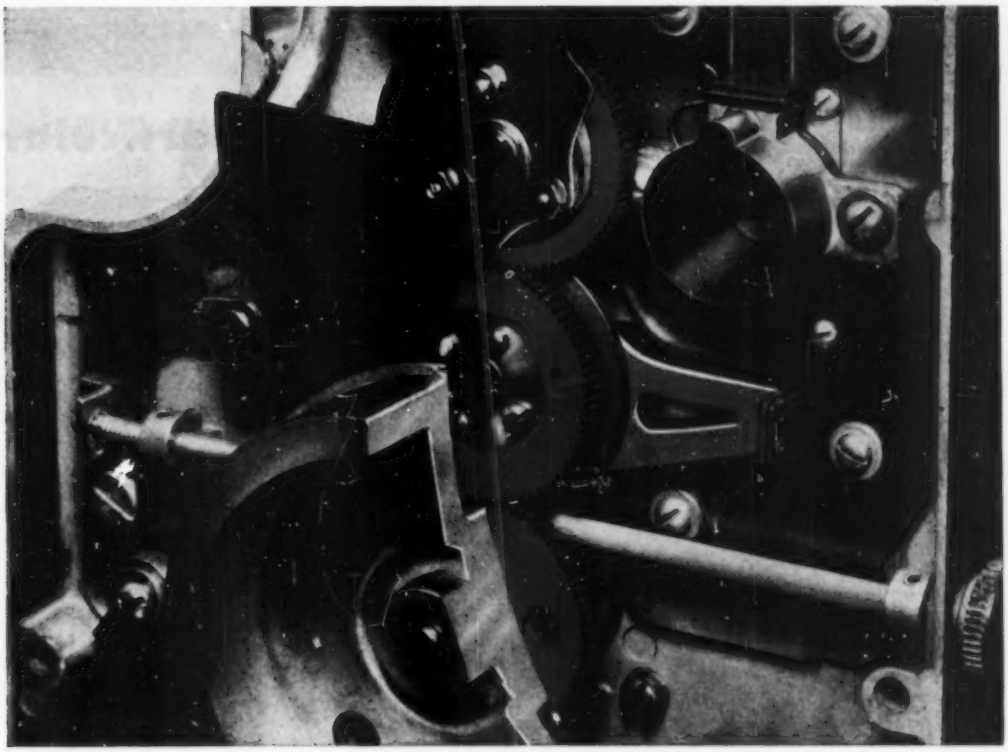
Many types and sizes of permanent magnets are available at once for your experimentations.

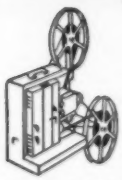
INDIANA PERMANENT MAGNETS

THE INDIANA STEEL PRODUCTS COMPANY

VALPARAISO, INDIANA • • • Sales Offices Coast to Coast

SPECIALISTS IN "PACKAGED ENERGY" SINCE 1908





RCA PROJECTOR IS GEARED FOR ECONOMY WITH MOLDED DU PONT NYLON

Nylon plastic gears cost 1/3 to 1/5 as much as former gears . . . give superior performance . . . last over 3 times longer!

". . . an excellent example of the right material in the right spot." That's what RCA says about these nylon gears, used to drive the projector intermittent in their RCA "400" 16-mm. sound film projector.

Lighter in weight, yet more durable than former gears, nylon gears are injection-molded 1⅝ inches in diameter with 48-pitch teeth. They are used in the drive revolving at 1440 r.p.m.

To begin with, mass production with injection-molded nylon enables RCA to make these gears at 1/3 to 1/5 the previous cost—a substantial saving. And nylon's resilience permits gear tolerances to be increased. Smooth-running nylon absorbs vibration . . . provides a quieter, more efficient gear drive that *requires no lubrication*. With all these outstanding properties, the nylon gears operate *over three times longer* than former gears!

Nylon plastic may well help you, as it has many other companies, to improve your product or effect savings. Demand for nylon currently exceeds supply. However, we suggest you investigate the versatile properties of nylon for future application, or product improvement.

We will gladly discuss the availability of experimental quantities for development work. Write:

E. I. du Pont de Nemours & Co. (Inc.)
Polychemicals Dept., Sales Offices:
350 Fifth Avenue, New York 1, N. Y.
7 S. Dearborn St., Chicago 3, Ill.
845 E. 60th St., Los Angeles 1, Calif.

Nylon gears molded by Atlantic Plastics, Inc., Stamford, Conn.

DU PONT
PLASTICS
Better Things for Better Living
. . . through Chemistry

Wagner
ELECTRIC MOTORS
...the choice of leaders in industry

it *pays* to be particular

the Wagner Type RA Motor Offers the Most Simplified Design to provide Repulsion Start . . . Induction Run

The Wagner repulsion-start induction motor is truly industry's general purpose single-phase motor, for both fractional horsepower and integral horsepower applications. It is especially suitable for driving machines having high inertia or excessive friction at starting because of its ability to start heavy loads with low starting current. This feature is most important in the larger fractional and in integral horsepower ratings.

This versatile motor is economical to maintain, requires only minimum servicing, is free from vibration and noise, and gives years of reliable service.

Build good will for your product by standardizing on Wagner Motors. There's a motor to fit your *exact* needs in Wagner's complete line. Bulletin MU-185 gives full information.

* * *

If you desire capacitor-start motors—Wagner capacitor-start motors will give superior performance. They are available in standard ratings from ⅛ to 3 horsepower.

Wagner Electric Corporation 1891 1951

WAGNER ELECTRIC CORPORATION
6406 PLYMOUTH AVE. • ST. LOUIS 14, MO., U. S. A.

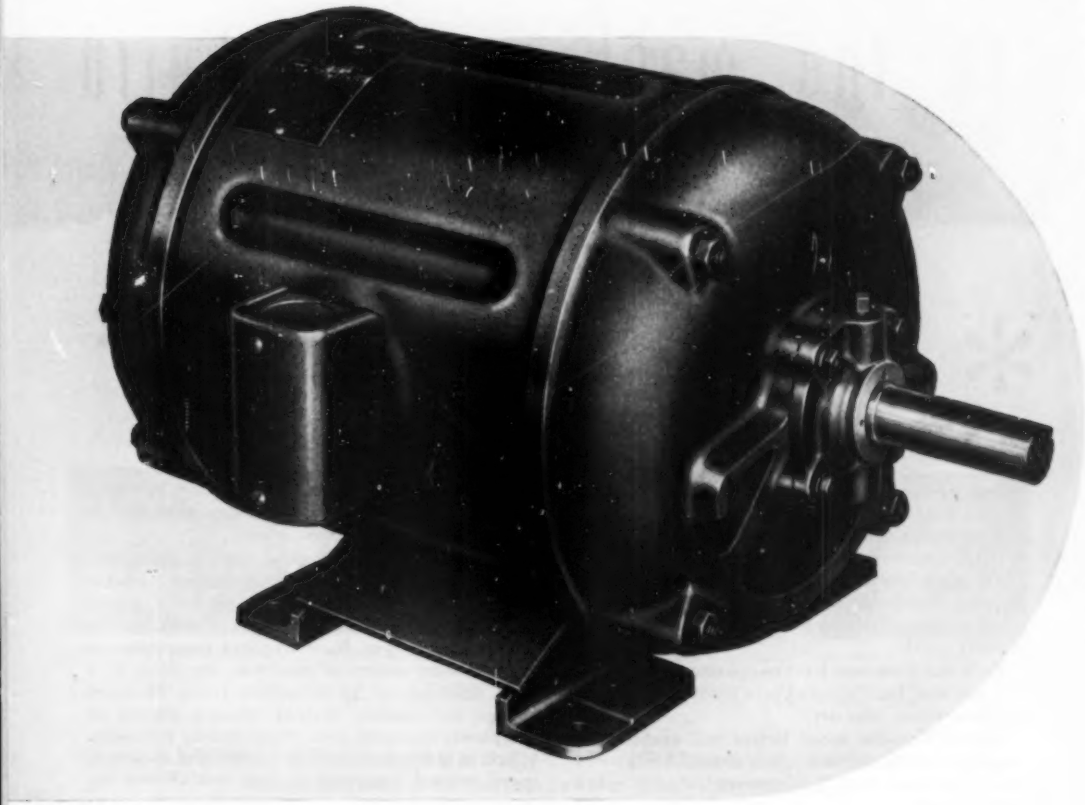
ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

AI.51-3

about your choice of motors . . .

Pioneered by Wagner more than half a century ago, the Wagner type RA offers the most troublefree design available, and is still the standard by which all other single-phase motors are judged.



The Wagner Type RA Motor starts as a repulsion motor with high torque but with extremely low starting current and switches to an induction motor while approaching rated speed to assure a high operating speed, even under overload, and a flat efficiency curve over a wide operating range.

How REEVES Speed Control adds Changeover Capacity* to the machines you build

* Changeover Capacity **the measure of a machine's ability for conversion to different jobs, different products and different materials.**

"Changeover Capacity" is important to your customers because many of them are not converting completely to defense work; instead, they are only *partially* converting.

The machines you deliver may have to operate for three or four days a week on consumer products—then be changed to operate for two or three days on military goods.

Your machines may have to operate on one material, one size, one day—and on a substitute material, a different size, next day.

REEVES Variable Speed Drives will enable your machines to do this—quickly, economically—will greatly increase their "Changeover Capacity"—and here is how:

Instantly, at the turn of the REEVES handwheel, or touch of a button

—your customer has the *right speed* for steel, aluminum, brass, plastic or any other material.

—your customer has the *right speed* for a different product, a different size, a different shape.

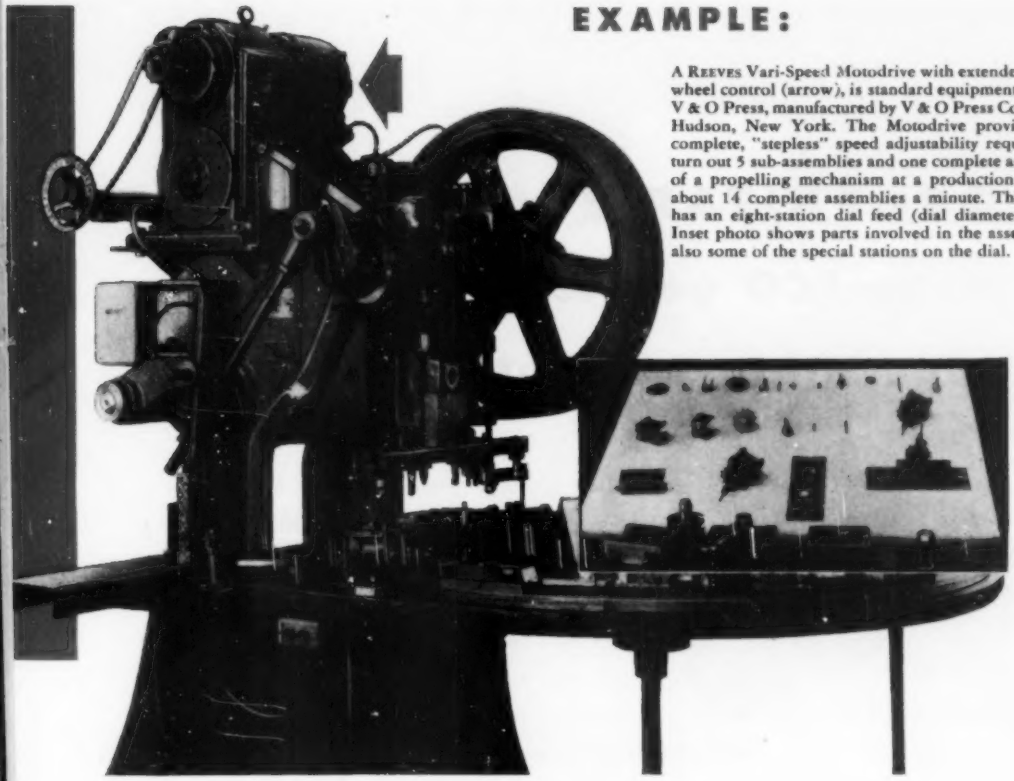
—your customer has the *right speed* for breaking in new operators, and for letting more skilled operators do their best work.

Increase your customer good will and strengthen your sales position by applying REEVES Variable Speed Drives to the machines you build. Speed changing is then "stepless," positive, selective to a fraction of an rpm. Now standard equipment on 2100 leading makes of machines. Available in a wide selection of hp capacities, ratios of speed change, and modern designs. Manual, electric or completely automatic controls, including hydraulic.

REEVES maintains a nation-wide staff of seasoned, speed control engineers to help you choose the proper unit and apply it correctly. Write for complete information.

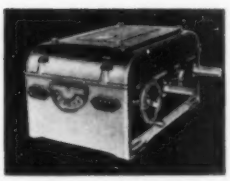
accurate · variable
REEVES Speed Control

EXAMPLE:



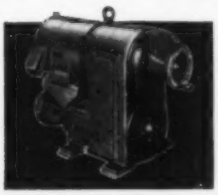
A REEVES Vari-Speed Motodrive with extended hand-wheel control (arrow), is standard equipment on this V & O Press, manufactured by V & O Press Company, Hudson, New York. The Motodrive provides the complete, "stepless" speed adjustability required to turn out 5 sub-assemblies and one complete assembly of a propelling mechanism at a production rate of about 14 complete assemblies a minute. This press has an eight-station dial feed (dial diameter, 60"). Inset photo shows parts involved in the assemblies; also some of the special stations on the dial.

REEVES Has the *Right* Unit for Every Variable Speed Need



VARIABLE SPEED TRANSMISSION provides infinite, accurate speed flexibility over a wide range—2:1 to 16:1. Sizes to 87 hp.

VARI-SPEED MOTOR PULLEY converts any standard, constant-speed motor to variable speed drive. Speed variations to 4:1, sizes to 10 hp.



MOTODRIVE combines motor, speed varying mechanism and reduction gears in a single unit. Speed variations 2:1 to 10:1 inclusive. Sizes ¼ to 20 hp.

VARI-SPEED, JR., a compact, low-cost unit, for light machinery. Takes any standard V-belt. Ratios, 1⅜:1 to 2⅜:1. Sizes—¼ through 1½ hp.

REEVES PULLEY COMPANY • COLUMBUS, INDIANA

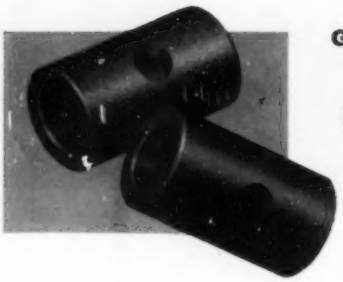
Recognized Leader in the Specialized Field of Speed Control Engineering

● Ask for complete information, including engineering drawings and technical data, on the complete line of REEVES Variable Speed Drives and Controls. Send for catalog No. K70-3N.

GRAPHITAR BEARINGS

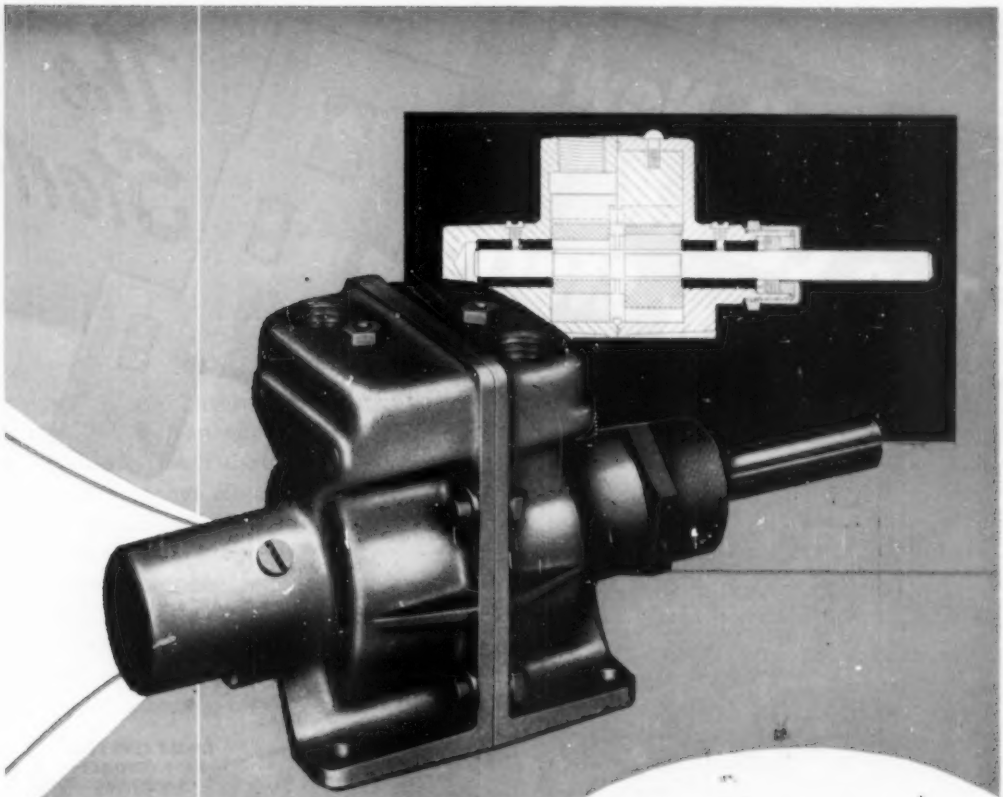
CARBON-GRAPHITE

keep ECO gearless pump operating without lubrication



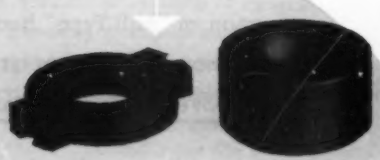
Graphitar bearings installed at both ends of the main pump shaft are helping the ECO Gearless Pump to operate without maintenance for long periods of time in scores of pumping jobs. ECO Gearless Pumps are designed for operation with gasoline or electric motors to handle a wide range of liquids and viscous fluids. The two Graphitar Bearings permit smooth and quiet operation of the pump, and because they require no lubrication, they eliminate the possibility of contamination by oils or greases of the liquid being pumped. Graphitar bearings operate efficiently at speeds from 300 to 3400 RPM at which the pump shafts are designed to operate.

THE UNITED STATES GRAPHITE COMPANY



Graphitar has helped scores of manufacturers solve an otherwise difficult manufacturing problem because of its many unique and valuable characteristics. Graphitar is extremely light-weight — lighter than magnesium — yet it is mechanically strong and resistant to wear. Graphitar is chemically inert and unaffected by temperature extremes. It is ideal for seals, rings, pistons, bearings and bushings — it can be produced in any practical size and shape with tolerances as close as .0005" in small sizes. An inquiry or a sketch of your product will give our engineers an opportunity to show you where Graphitar parts may improve mechanical performance and save you money. We have a catalog which we will gladly send you.

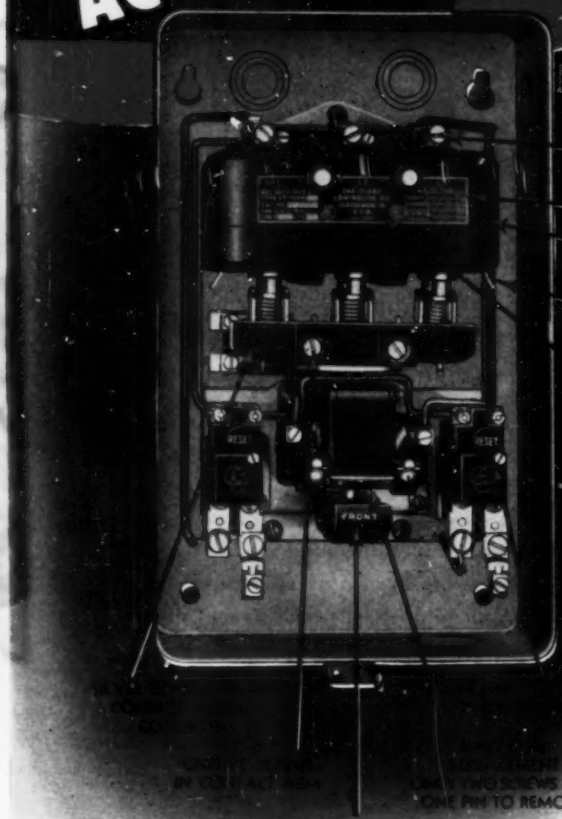
GRAPHITAR



DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

It's All New! The CLARK "CY" AC Motor Starter

The Starter



PRESSURE TYPE TERMINALS LINE AND LOAD

ONE PIECE UPPER ARC SHELL PROTECTS TERMINALS FROM HOT GASES

ARC SHIELDS INORGANIC NON CARBONIZING MATERIAL

FINGER CLIPS FOR EASY CONTACT INSPECTION

MAGNETIC ARC INTERRUPTERS WITH STEEL ARC CHAMBERS

VERTICAL LIFT MAGNET WITH STEEL GUIDE USES NO SPRINGS

another CLARK FIRST!

Here, for the first time is a rugged AC magnetic starter that provides the extra protection and dependable operation of "Mill-Type" heavy-duty construction and design at *no premium above ordinary starter prices!*

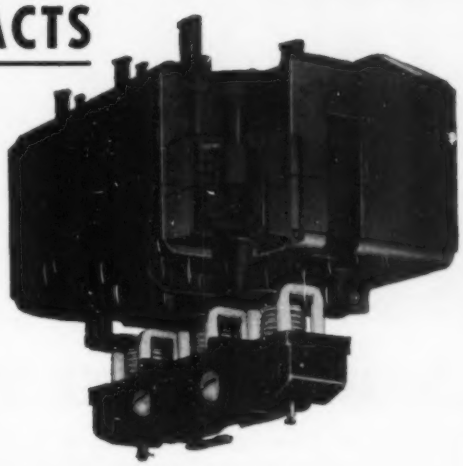
Let a CLARK application engineer show you what this BLUE RIBBON PRODUCT means to you in increased production and lower maintenance.

CLARK ENGINEERED ELECTRICAL CONTROL

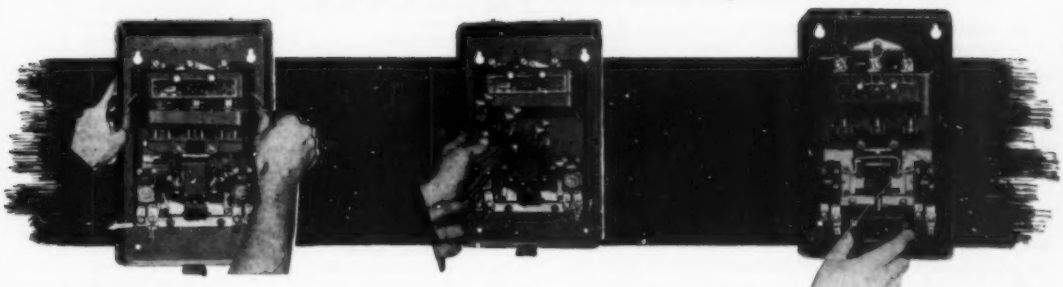
with the sensational NEW multi-turn magnetic blowouts

and TWIN-BREAK CONTACTS

The "CY" starter employs an entirely new principle of arc interruption. The arc is extinguished by the effect of the blow-out coil, *concentric with the contact.* The magnetic field quenches the arc either by lengthening or confining it. In its *forced rotation* it moves continually from a hot to a cold spot —preventing burning or pitting of contacts. The ingenious design of the arc chamber prevents carbonization and the accumulation of ionized gases between wiring terminals —minimizing phase-to-phase failures.*



The Maintenance Man's Dream!



- No filing, dressing or cleaning of contacts!
- No tools necessary to inspect contacts!
- Easy to change moving contacts!
- Stationary contacts changed quickly with screw driver!
- Only two screws and one pin to remove to change coils!
- Only four screws to remove to take out stationary magnet frame!
- Power circuit contacts available with springs in complete packaged service kits for ease in stocking!

**Magnetic blow-out coils are used on all size 2 and 3 "CY" starters. Sizes 0 and 1 use the same general Mill-Type construction as the larger sizes.*

THE CLARK CONTROLLER CO.

1142 EAST 152ND STREET · CLEVELAND 10, OHIO

...IN FLAME HARDENED OR HEAT TREATED MEEHANITE CASTINGS

The adaptability of Meehanite castings to all the modern types of heat treatment including local flame hardening are numerous and include:

1. Improved engineering properties—tensiles up to 80,000 psi; Brinells up to 600 and toughness.
2. Maximum hardness penetrating uniformly to over ½ total depth of case.

The metallurgical structures of the higher property types of Meehanite castings are, of course, carefully regulated and respond to heat treatment uniformly with properties which can be predicted according to established procedure.

A typical example is illustrated. A Meehanite Type GA worm heat treated to 350 Brinell, ground to mirror smoothness is mated with a Meehanite Type GC worm gear. In the manufacture of certain types of mining equipment this combination is specified regularly as a result of both tests and experience in the field. Previous combinations of other materials frequently resulted in galling and scoring of the worm and resulting deterioration of the worm gears.

Properties of the worms as cast and after heat treatment are as follows:

Worm as Cast	After Heat Treatment
Tensile 55,000 psi	68,000 psi
Transverse 3400 lb	4000 lb.
Brinell 230	350

WHEN YOU NEED "EXTRAS" IN QUALITY OR PROPERTIES CONSULT ANY OF THE FOUNDRIES LISTED BELOW

American Brake Shoe Co	Mahwah, New Jersey
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E. W. Bliss Co	Hastings, Mich. and Toledo, O.
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Continental Gin Co	Birmingham, Alabama
Crawford & Doherty Foundry Co	Portland, Oregon
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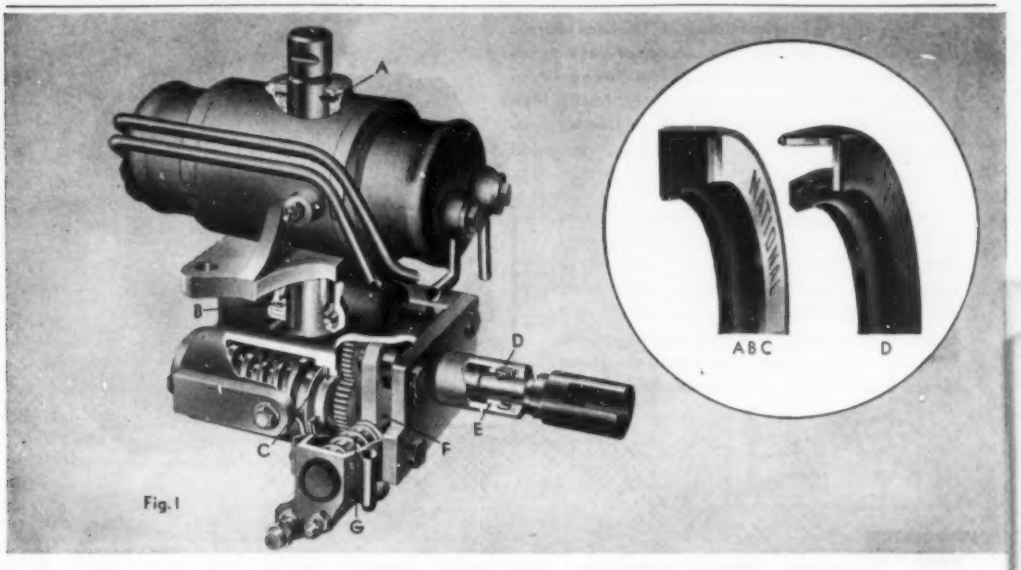

Fig. 1

Oil Seals and "O" Rings are vital components in the new hydraulic steering gear

The sealing problems encountered in the new Gemmer Steering Gear units are many and varied. There is a complete hydraulic system with a complexity of regulating valves in addition to rotating, oscillating and eccentric shafts. Spur and worm gears are lubricated in regular manner and hence must be isolated from the hydraulic system.

The cut-away drawing (Fig. 1) shows arrangement of spur and worm gears and the position of actuating valves and the hydraulic cylinders which power the mechanism. There are a total of four National Syntech Oil Seals and 25 "O" Rings used in this mechanism. Two National Syntech* 240,000 series springless oil seals are located on the shaft (A&B) which operates the pitman arm. A third Syntech 240,000 seal is located between the lower spur gear and the worm drive (C). This arrangement isolates the worm gear from the spur-gear compartment, permitting separate lubrication of these gears.

A National Syntech rubber-covered, spring-tensioned oil seal (D) is located just outside the spherical bearing (E) on the steering-post shaft. As the steering wheel is turned, this shaft rotates and also moves angularly to actuate the hydraulic valves. The angular movement is developed by the tendency of the upper spur gear to rotate around the lower one, causing the operating block (F) to open or close the valves (G). The National 350,000 Syntech Oil Seal is subjected to constant and varied eccentric shaft movement.

All the oil seals in this application are subjected to varied pressures up to 50 psi which, because of relatively slow shaft movements, is well within their performance capabilities.

Providing good bearing protection under operating circumstances of this kind is a real tribute to the performance capabilities of National Syntech Oil Seals. The sealing-lip design provides the utmost of flexibility and at the same time effects a positive seal around the shaft despite the eccentricity.

The Gemmer Power Steering Gear is an outstanding new mechanical device and it offers a striking example of economical design insofar as oil seals are concerned. Three of the oil seals being used are regular stock designs, hence considerable time and special engineering were saved during the course of its development. If you have a sealing problem of any kind, National Oil Seal engineers will be glad to cooperate.

"Let Your Decision be Based on Precision"

NATIONAL
OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

2275

* *Trade Mark Registered*

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DALLAS, TEXAS . . . . *30½ Highland Park Village, Justin 8-8453*
DETROIT, MICH. . . . . *726 Lothrop Avenue, Trinity 1-6363*
DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., Topaz 2-8166*
MILWAUKEE, WIS. . . . *647 West Virginia Street, Broadway 1-3234*
NEW YORK CITY, N. Y. . . . *122 East 42nd Street, Lexington 2-8260*
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when the ACCENT is on the Positive.

. . . then the positive pumping of Fairbanks-Morse Rotary Pumps offers the best choice for your equipment. They efficiently handle any free-flowing liquid from gasoline to molasses with exceptionally high efficiency. Non-fluctuating load characteristics minimize shock and vibration . . . assure long, economical service.

Only TWO parts move in Fairbanks-Morse Rotary Pumps . . . a precision-cut rotor and pinion gear. There are no complicated parts to cause trouble or to require frequent maintenance and adjustment. Capacities range from ⅛ to 5 inches. If your design problems involve positive pumping, choose from the Fairbanks-Morse Rotary Pump line . . . the economical choice.

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A NAME WORTH

..when HEADS are up or down

A Fairbanks-Morse Westco turbine-type pump is the efficient answer. The unique design employed in these exceptionally compact pumps permits them to handle widely varying heads with little or no loss of capacity. Maximum capacity is obtained at an operating speed of 1750 r.p.m. when discharging at low pressure, and high pressures are developed at the same speed with little change in capacity. In addition, through the use of a single-stage, multi-vaned impeller, Westco Pumps give you multi-stage performance from a single-stage pump. Westco Pumps are widely used as integral parts of machines, units or systems. Capacities from 1 to 200 g.p.m. Check them for your equipment.

Built-together Centrifugals

Other FAIRBANKS-MORSE Pumps Include

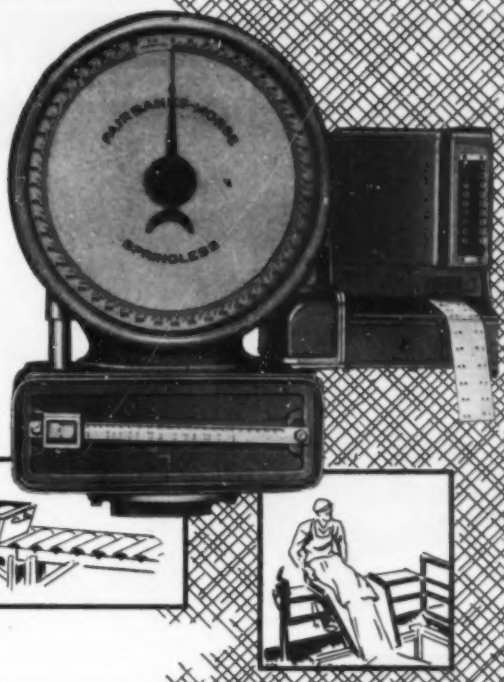
Side-Suction Centrifugals

Single and Two-Stage Centrifugals

when it's a problem of CONTROL

. . . consider the advantages of control by weight! Fairbanks-Morse Printomatic Weighers with electronic attachments accurately control production and processing operations. Materials handling operations, conveyor systems, processing and batching operations can be accurately controlled by these precision instruments. They can open and close valves controlling material flows to predetermined quantities. Templets can be used to preserve formula secrets when compounding mixes.

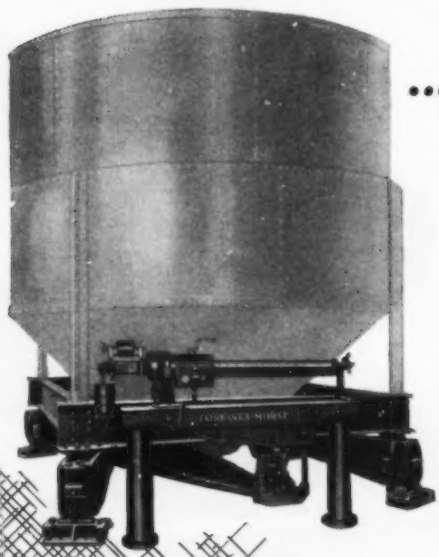
In addition, accurate records of materials can be kept since the Printomatic will furnish printed records of operations. The human element and chance for error are eliminated. Check your Fairbanks-Morse weighing expert on the advantages Printomatic offers you.



-MORSE

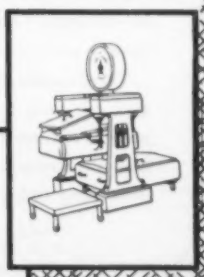
REMEMBERING

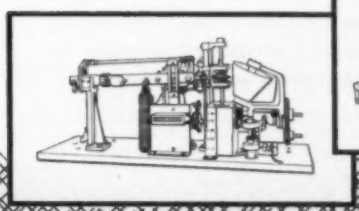
See Next Page for FAIRBANKS-MORSE Sales Centers



...when it's a problem in weight

. . . the easy answer is in the complete Fairbanks-Morse scale line. Beam scales or dials, belt conveyor scales, aggregate weighing scales, proportioning and batching scales, truck scales, furnace charging scales, you'll find them all and more. An important point—Fairbanks-Morse Scales *or component scale parts* can be supplied to fit right into your equipment for weight or control operations. Your Fairbanks-Morse weighing expert will be happy to work with you on any scale problem.





MOST Advantages for MOST Motor Applications

STANDARD DRIP-PROOF MOTORS FOR YOUR PROTECTION

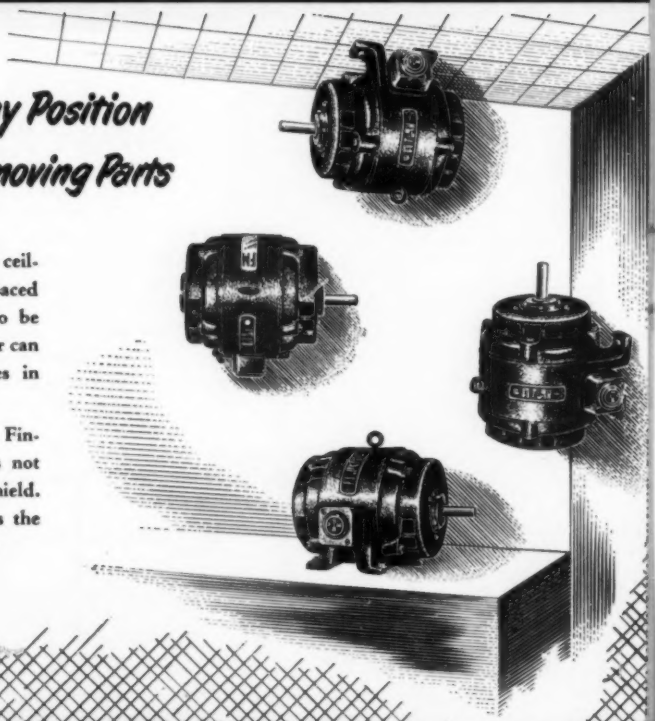
Practically every motor needs protection—from flying chips, falling particles, dripping liquids, and the like. Also, by far the majority of motors used are of the polyphase, squirrel cage type.

These requirements are met to a unique degree by this series of Fairbanks-Morse motors—with built-in protection and superior electrical and mechanical design that account for their popularity throughout industry.

Whether your motor application problems involve driving pumps, machine tools, compressors, elevators, fans—or any of an infinite number of other applications—Fairbanks-Morse Standard Drip-proof Motors deserve your early investigation. Call your nearest Fairbanks-Morse Sales and Service center.

FAIRBANKS
A NAME WORTH

PROTECTION.. *in any Position*
SAFETY.. *no Exposed moving Parts*



Mount these motors anywhere—even on the ceiling or walls. Bearing arms have four bolts spaced 90° apart, enabling the bearing brackets to be adjusted to assure maximum protection. Motor can be mounted vertically without any changes in bearing construction.

There is complete safety for the operator. Fingers can even be placed in vents, for it is not possible to contact fans due to the protective shield. Smooth, streamlined external contour makes the motor easy to keep clean, easier to maintain.

Cross Flow Ventilation...Copper Spun Rotor

...OTHER UNIQUE FEATURES

Cross Flow Ventilation is an exclusive Fairbanks-Morse design that eliminates hot spots, prolongs the life of the stator installation.

Copperspun Rotor: a truly one-piece indestructible copper winding that withstands higher temperatures, has high electrical and thermal conductivity, better dynamic balance.

Rugged Frame Construction: Protection in any mounting position.

General purpose continuous duty: rated 40° C. and designed to carry 115% load continuously without injurious heating (1.15% service factor).

High efficiency, high power factor, good starting and accelerating torques.

Unique conduit box provides alternate assembly: either recessed, flush with frame or conventional external mounting.

Mounting dimensions conforming to NEMA standards.

Arrows show double flow of air that keeps motors running cool!

FAIRBANKS-MORSE

REMEMBERING

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WA 2-4100

PITTSBURGH 24, PA.
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SCheniey 1-3123

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EAst 0131

PROVIDENCE 3, R. I.
187 Pine Street
GAspee 1-1531

ST. LOUIS 2, MO.
217 South Eighth St.
CHestnut 7483

ST. PAUL 1, MINN.
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SALT LAKE CITY 1, UTAH
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3-2108 & 3-5139

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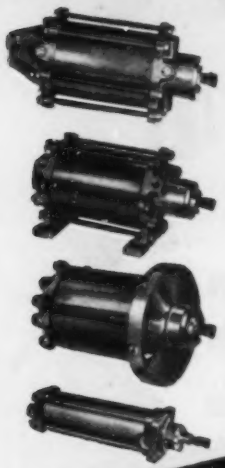
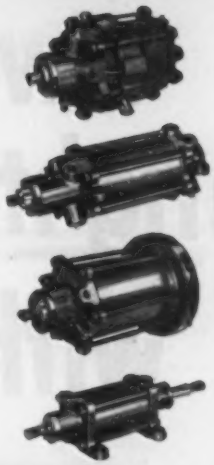
HANNIFIN has them!



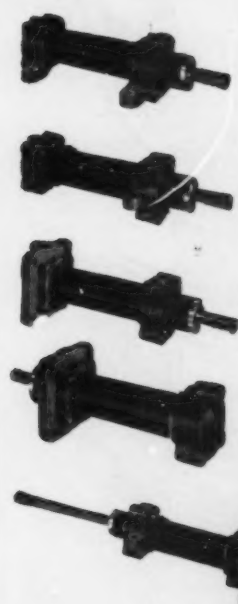


HERE'S help for busy machine designers and plant operating engineers. Chances are you'll find just the cylinder you want, completely dimensioned in one of Hannifin's two big cylinder catalogs. Hannifin offers more cylinders—we think better cylinders—than any other maker!

STANDARD CYLINDERS

Hannifin's many mounting types meet most design requirements. Wide choice of bore diameters. Any stroke you specify. Cushioned or non-cushioned. Air cylinders (also available for low pressure hydraulic service). Hydraulic cylinders for pressures to 1500 psi. Used by machine designers in many fields. Usually the economical choice because of Hannifin's large production of standard models.

What Kind of CYLINDERS Do You Need?



CUSTOM CYLINDERS

Hannifin also offers many special designs to meet space limitations, for special mounting conditions, for pressures other than standard. We supply these in small quantities to makers of special machines, in larger quantities to the material handling, farm implement, and similar fields. Where considerable quantities are involved, a custom cylinder—tailored to the exact requirements of the job—is often actually cheaper.

Let Hannifin engineers help you get the BEST solution for your cylinder problems. Call in your local factory-trained Hannifin field engineer today.

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MORSE DRIVE SHAFTS (in five series and three types)

TRANSMIT POWER ECONOMICALLY RELIABLY WITHOUT LUBRICATION

Flexible Morse Drive Shafts provide a cushioned drive between separated units. They provide torsional flexibility, absorb shock, and isolate vibration while transmitting power noiselessly, dependably, safely, and economically. Four of the five series accommodate end float *and* provide full universal action.

Look over the condensed descriptions of Morse Drive Shafts on this page. In addition to the standard sizes shown, special drive shafts can be made for unusual applications. Write us for more complete information.

MORSE CHAIN COMPANY
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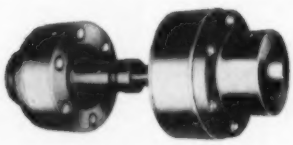
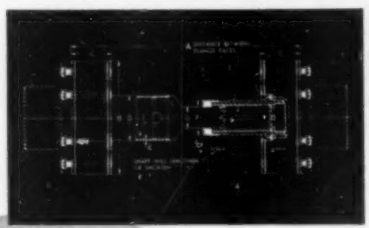
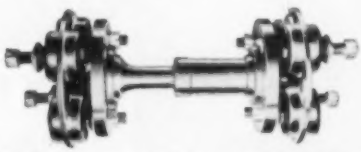


Series RS (Radial Coupling Drive Shaft)—Provides end float plus added capacity. Five assemblies ranging from 158 to 2127 lbs.-ft. torque capacity. Inter-flange distance from 10⅝" to 14⅝". HP capacity from 3 to 40½ per 100 RPM.

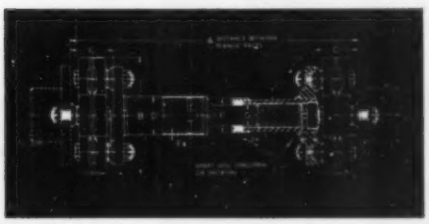


Series RT—Basically an RS Drive Shaft with tubular shaft welded to each end member to provide additional length. Five assemblies ranging from 158 to 2127 lbs.-ft. torque capacity. Inter-flange distance from 11⅛" to 84". HP capacity from 3 to 40½ per 100 RPM.

Series T—Solid or tubular depending on capacity. Ten assemblies ranging from 13 to 725 lbs.-ft. torque capacity. Inter-flange distance from 3⅛" to 84". Misalignment compensation proportional to length of tube. HP capacity from .25 to 13.80 per 100 RPM.



Series S—Grease-tight slip joint permits end float. Provides full universal action. Six assemblies ranging from 84 to 725 lbs.-ft. torque capacity. Inter-flange distance from 10⅞" to 17⅛". Maximum 5° angular misalignment compensation. HP capacity from 1.60 to 13.80 per 100 RPM.



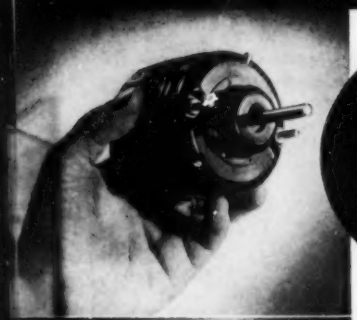
Series ST—Basically a Series S Drive Shaft, with tubular shaft welded between hub and yoke members to provide additional length. Six assemblies ranging from 84 to 725 lbs.-ft. torque capacity. Inter-flange distance from 11⅞" to 84". Misalignment compensation proportional to length of tube. HP capacity from 1.60 to 13.80 per 100 RPM.

M=PT
Morse *means* Power Transmission

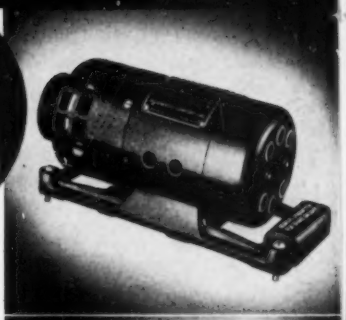
MORSE
MECHANICAL
POWER TRANSMISSION
PRODUCTS

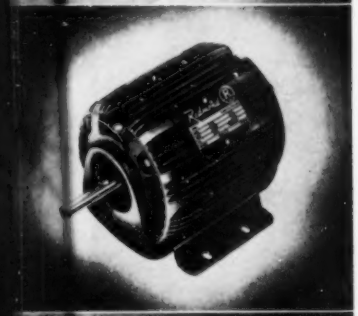
PRODUCTS OF B-W BORG-WARNER

Built for MILITARY REQUIREMENTS



Redmond MICROMOTORS





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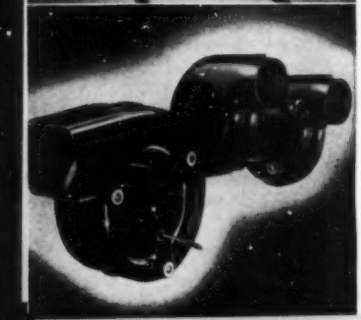
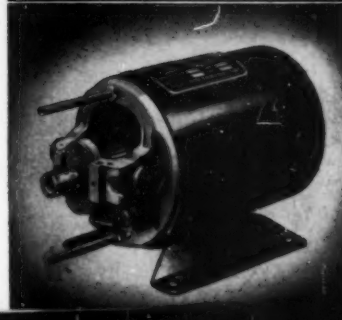
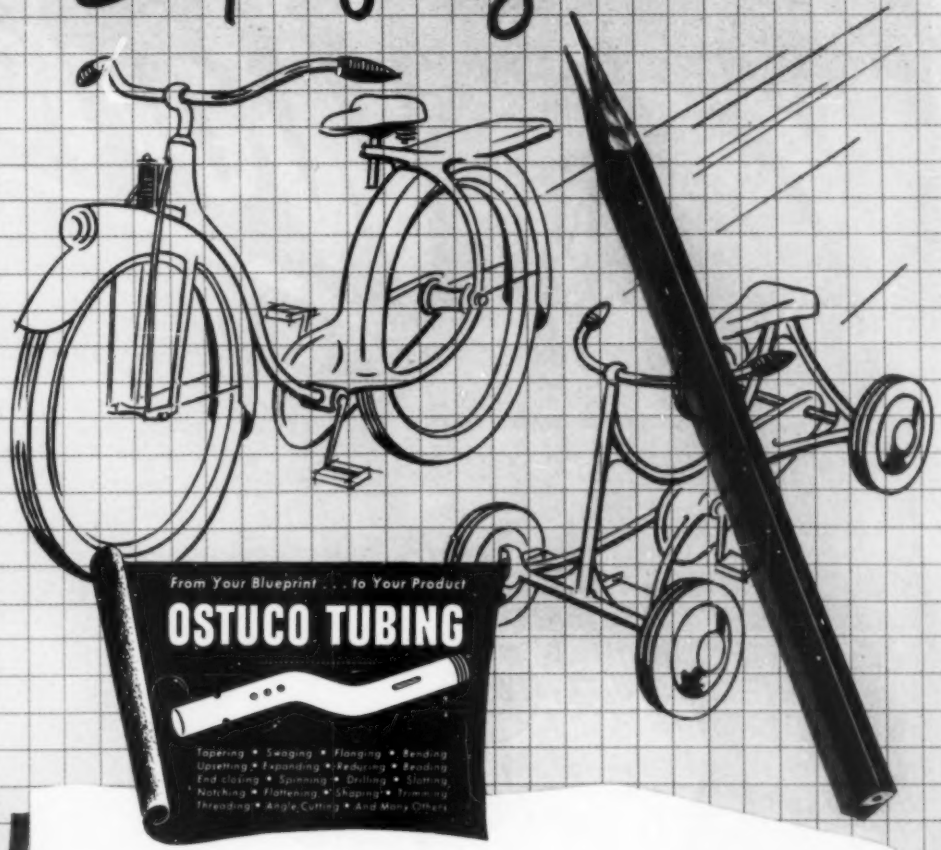




REDMOND COMPANY, INC., Owosso, Mich., U.S.A. INDUCTION MOTOR SALES OFFICES: *Eastern Area: 420 Lexington Ave., New York 17, N. Y.; Central Area: Owosso, Michigan; Midwest Area: 332 S. Michigan, Chicago 4, Ill.; Southwest Area: 1330 N. Industrial Blvd., Dallas, Texas; Western Area: (Redmond Company of Calif., Inc.) 1260 S. Boyle Ave., Los Angeles 23, Calif.* **SERIES MOTOR SALES OFFICES:** *Owosso, Mich.* **OVERSEAS SALES OFFICES:** *420 Lexington Ave., New York 17, N.Y., cable address, REDISINC - NEW YORK.*

Shape of things to come...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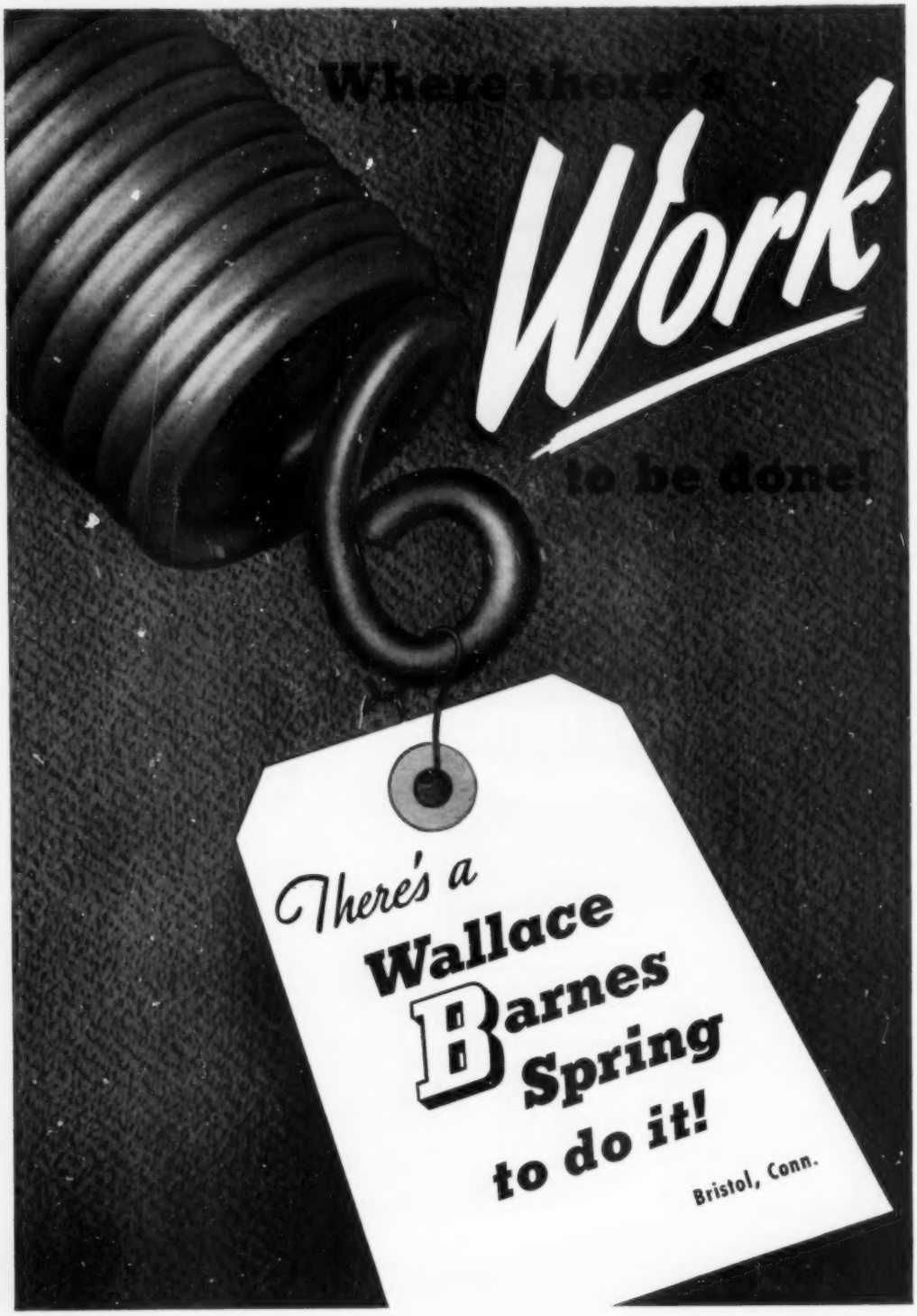
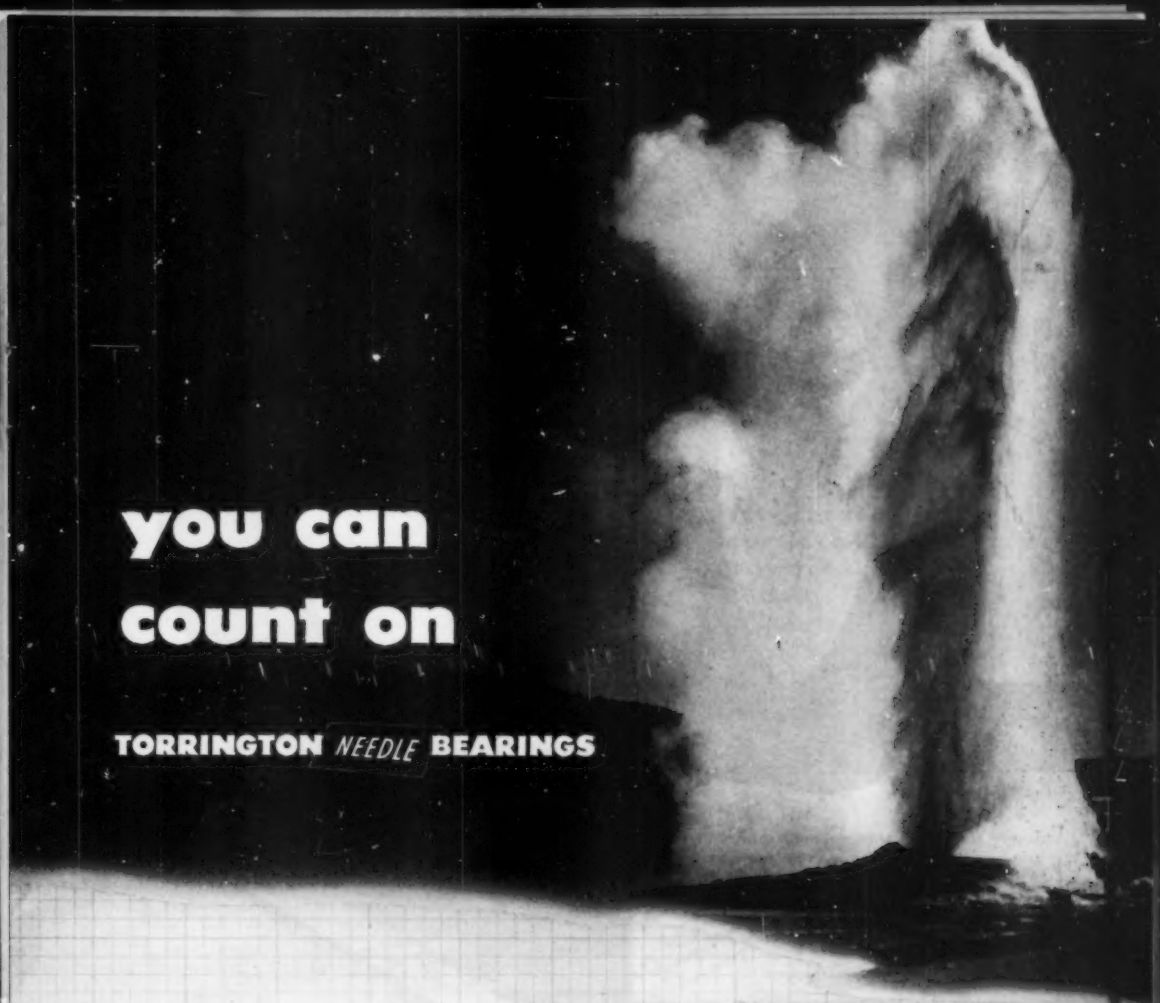
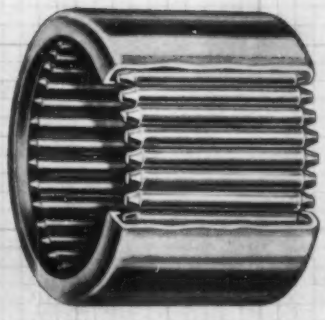

Where there's
Work
to be done!
There's a
Wallace
Barnes
Spring
to do it!
Bristol, Conn.



you can count on

TORRINGTON *NEEDLE* BEARINGS



. . . for faithful performance and smooth anti-friction operation.

. . . for savings in machining time and costs. No grooves or shoulders are needed . . . just a plain bore housing machined to proper dimensions.

. . . for fast, economical assembly. A simple arbor press operation seats the bearing by press fit. Spacers or retainers are not required.

And you can help your customers reduce maintenance. Needle Bearings require a minimum of service attention.

Our engineers will be glad to help you put these and other Needle Bearing advantages into your product.

THE TORRINGTON COMPANY

Torrington, Conn. • South Bend 21, Ind.

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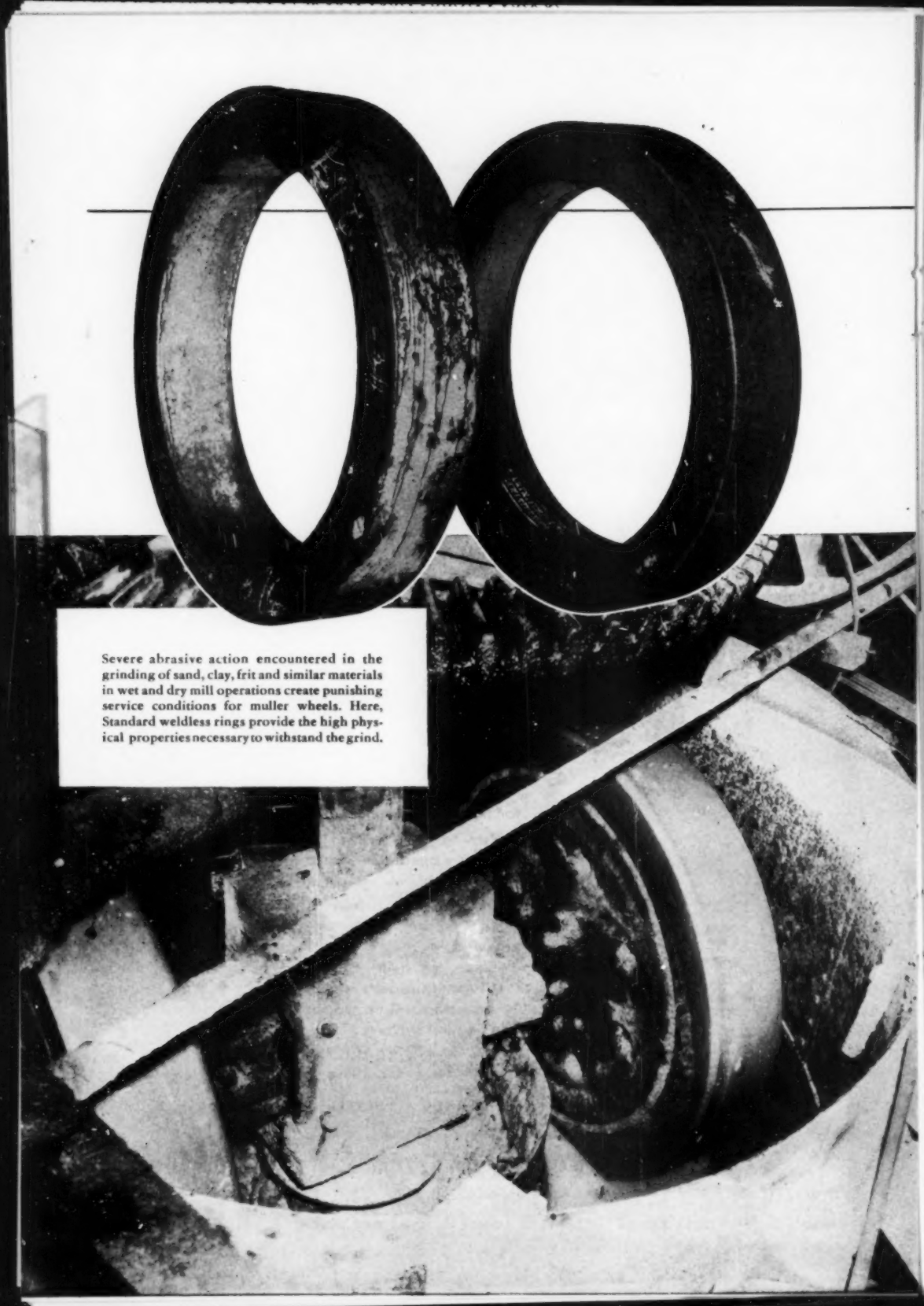
TORRINGTON *NEEDLE* BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS



Severe abrasive action encountered in the grinding of sand, clay, frit and similar materials in wet and dry mill operations create punishing service conditions for muller wheels. Here, Standard weldless rings provide the high physical properties necessary to withstand the grind.

WHEN THE JOB CALLS FOR WELDLESS RINGS

Ring for STANDARD

Whenever you have a job that calls for weldless rings, you'll find that Standard provides important advantages in craftsmanship, experience, and facilities to give you rings that are uniform in strength and structure. Made from steel produced in Standard's own open hearth furnaces, the composition and properties of these products are precisely maintained to specification. Rolling practice reflects 55 years of experience in the manufacture of rings and tires, and the controlled cooling rates and the subsequent heat treatment substantially improve service qualities.

Rings are vital parts of hundreds of different industrial machines and devices. When special properties and special quality are needed in rings for *your* equipment, remember that these Standard products are ringleaders in industrial circles.

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WHEEL MILL PRODUCTS, STEEL CASTINGS, WELDLESS RINGS, FORGINGS, FLANGES

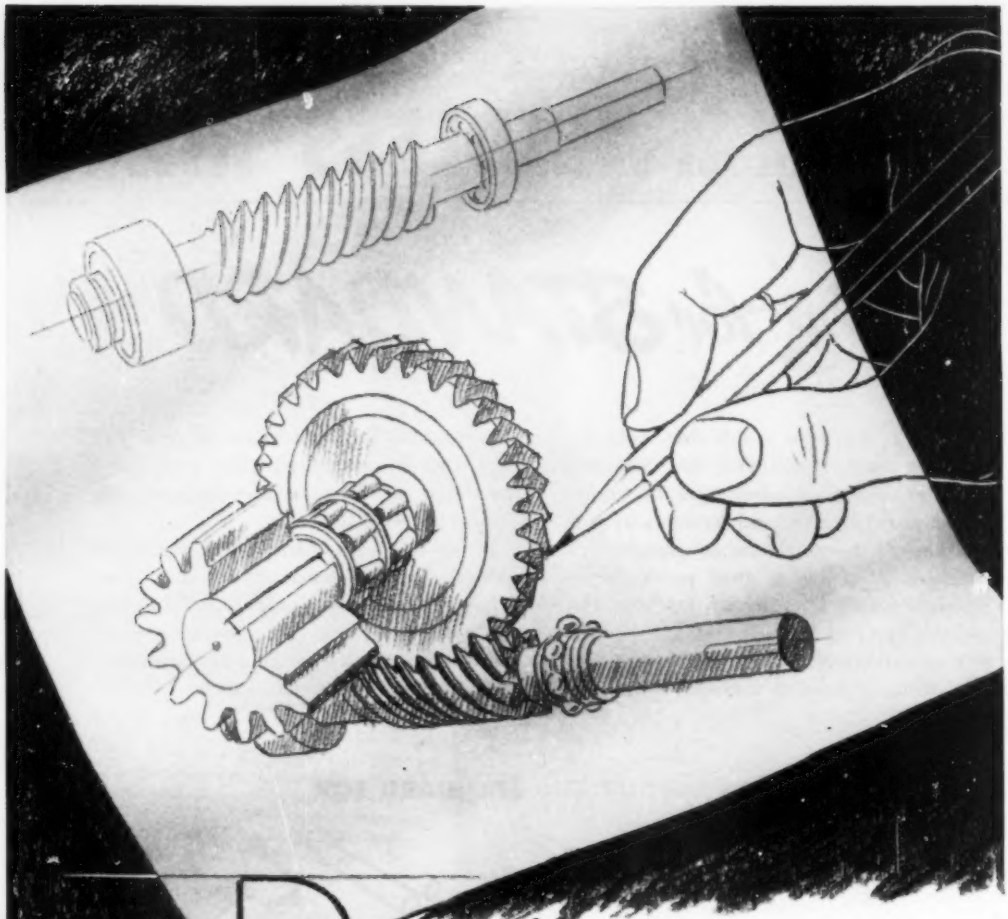
NOTICE: DESIGN AND PURCHASING DEPARTMENTS . . . Standard's three-unit mill—each composed of a horizontal mill and two steam hammers for preliminary operations—can roll practically all sizes of rings up to a maximum of 12 feet outside diameter. Let us quote on your requirements.

BALDWIN BLH LIMA-HAMILTON

BALDWIN-LIMA-HAMILTON

STANDARD STEEL WORKS DIVISION

Baldwin-Lima-Hamilton Corporation, Standard Steel Works Division, Burnham, Pa. **Offices:** Chicago, Cleveland, Houston, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis, Washington.



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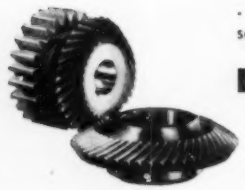
Planning how torque may be applied through gears is a service which, at BRAD FOOTE, we call design. Here . . . in our own plant . . . we have engineers with long experience designing better, more efficient gear assemblies.

- These men well know BRAD FOOTE's creed—"*No one shares our responsibility.*"
- They know the gears they design—for use in your shop or on the equipment you sell to others—will bear a proud brand name—BRAD FOOTE.

So, our designers start your order on its journey through our plant . . . and through a system of complete control which assures satisfactory performance of the gears you buy.



BRAD FOOTE GEAR WORKS, Inc.

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Cicero 50, Illinois

Materials ~ AVAILABILITY AND TRENDS

CONSERVATION CONFUSION

If Washington planners don't know what's most scarce, then who does? One division of NPA recently told a business group that fibrous glass was so scarce it might have to be allocated. A few days later, another NPA division recommended that asbestos users switch to fibrous glass as an available substitute.

Top-level confusion within NPA about copper is typical of what is going on during these days of "relaxation". Policymakers who sit close to the NPA director are quoted officially about the possibility of relaxing copper controls. But in the copper division itself, the talk is all about increasing shortages and the possibility of tightening controls.

Defense Production Administration's Conservation Coordination Division hopes to end this confusion by developing a list of materials in order of scarcity. Howard Coonley, its director, is an old hand at conservation programs; he served in a similar capacity with WPB during World War II. His job is complicated because he can't issue directives himself.

NPA'S ROLE

Unlike DPA, the National Production Administration (NPA) issues orders--but industry helps formulate these orders. Here is how it is operating to get the most electrical equipment from a "given amount" of raw materials.

This is a typical problem NPA turned over to special "task forces" of its business advisory committees: The NPA advisory committee for the electric motor and industrial control manfuacturers reported it was having trouble getting copper and aluminum. How about standardizing products to eliminate "luxury specifications"? How about substituting relatively plentiful materials for those in scarcest supply? How about simplifying design to save material? Separate committees were named to come back with recommendations.

Conservation studies are being made in a broad line of products outside the electric equipment industry. They must be conducted in strict accordance with NPA rules, to avoid infringement of anti-trust laws.

CONSERVE ZINC

The electrical conduit advisory committee told NPA important amounts of zinc could be saved by halving requirements for conduit coatings. They recommended a change from a four dip requirement to two dips for indoor conduits, with the addition of two coats of weather-proof paint for outdoor use. The domestic communications operating advisory committee told NPA it was already conserving materials by: (1) Reducing the sizes of wire, cable and cable coatings; (2) substituting synthetic rubber for natural rubber; and (3) using lead for zinc in some galvanized coatings on hardware.

ALLOY STEEL: FIRST VICTIM

Alloy steel makers are getting ready for an allocation order by setting up melt sheets for NPA use. The melt sheets will show how much of each type of alloy was produced, who bought it, and what use it is being put to. This a direct step toward complete allocation of alloy steels under the Controlled Materials Plan scheduled to go into effect July 1. Designed to spread available material "equitably" among users, the alloy steel program will probably serve as a guinea pig for the whole CMP.

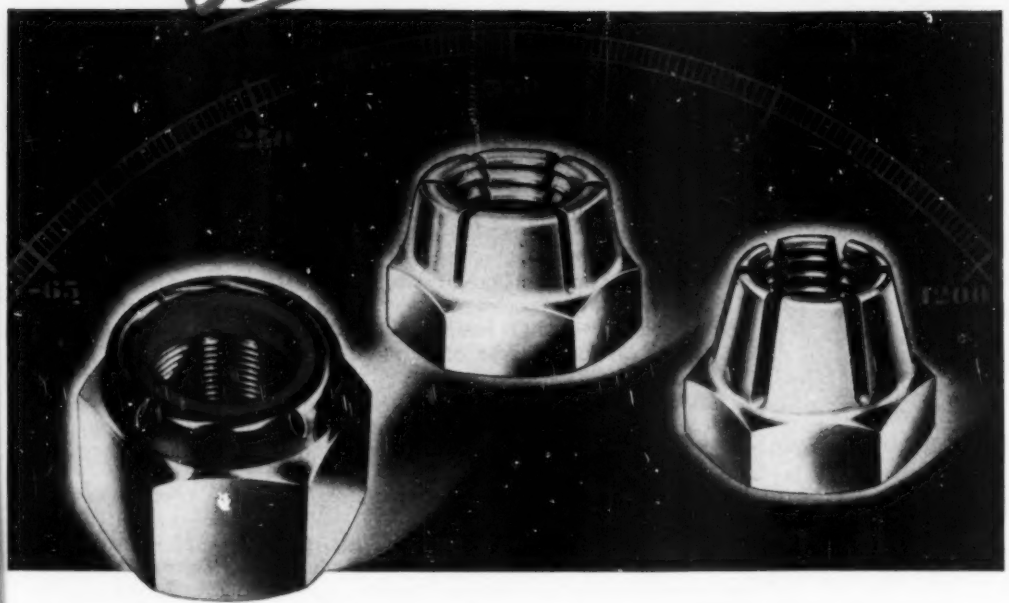
*(Continued on Page 97)**

NOW!

ESNA spans the temperature field

-65°F to +1200°F

with SELF-LOCKING ELASTIC STOP NUTS



—*famous Elastic Stop Nuts protect permanently against* VIBRATION! IMPACT!

With the addition of the new Z-550 and Z-1200 series, ESNA now has a specific nut design for all temperatures ranging from minus 65° F. to plus 1200° F. Self-locking, in both fully seated and positioned settings, these fasteners provide permanent protection against *vibration, impact* and *stress reversal.*

The two new nut designs represent the most efficient solution found by ESNA engineers after detailed research and production line studies of fastening problems encountered under elevated temperatures. Both fully meet ESNA standards for controlled quality and full interchangeability on class 3 bolts with minimum torque scatter. This controlled torque which is a feature of all ESNA nuts assures uniform bolt loading and permits more compact design, with resulting weight reduction. It also simplifies maintenance problems and speeds up field replacements.

Specifically, for applications between −65° F. and +250° F., the nut with the famous red fiber collar offers unequalled protection against vibration, thread corrosion and liquid seepage. The ZM and ZE nuts are designed for sustained temperatures up to 550° and the Z-1200 series has been engineered to withstand multiple cycles of exposure to extreme temperatures up to 1200° F. without seizure. Like all Elastic Stop Nuts, these fasteners are readily removed—do not damage threads or gall the finish—and they can be reused.

HERE'S A CHALLENGE: Send us complete details of your toughest bolted trouble spot. We'll supply test nuts—FREE, in experimental quantities. Or, if you want further information, write for literature. Elastic Stop Nut Corporation of America, Union, N. J. Representatives and Agents are located in many principal cities.

ESNA

ELASTIC STOP NUTS

HIGH TENSILE · ANCHOR · WING · SPLINE · CLINCH · GANG CHANNEL · NYLON CAP

OVER 440 TYPES AND SIZES IMMEDIATELY AVAILABLE FROM STOCK

Meanwhile type 317 stainless steel is knocked out of production by NPA's latest molybdenum order. The order limits molybdenum in stainless steel to 2.5 percent; type 317 requires from 3 to 4 percent. The new order also restricts type 316 which has had a variable moly content, from 2 to 3 percent, to a flat 2.5 percent. And speaking of stainless--a reliable industry source predicts that next year's supply of stainless steel for "permissible non-defense uses" may be as much as 70 percent short of this year's total.

BORON STEEL

Boron steel is back. First discovered during World War II as a method of saving nickel, chromium and molybdenum, many misconceptions concerning the effect of boron in steel have arisen. Just "add a pinch of boron" says one business publication.

Boron is used in steel for one purpose only--to increase the hardenability; that is, to increase the depth to which the steel will harden when quenched. While it is true that a very small amount may be substituted for several hundred times its own weight of other alloying elements, very close metallurgical control of the process is necessary. If the steel is overheated in the furnace or soaking pit, effect of the boron is lost. And the exact temperature at which the effect is lost is not known.

But if this problem is licked, boron--from cheap and plentiful borax--should help relieve alloying element shortages. Two-thousandths of one percent of boron would be equivalent to each of the following percentages of alloying elements in steel: 0.30 Mn or 0.35 Mo or 0.5 Cr or 2.4 Ni. Applications could be in cold headed bolts, induction hardened diesel crankshafts, large tractor bull gears, and hand tools.

NICKEL TIGHTEST

Nickel would be near the top of any scarcity list drawn up right now. Defense demands may be as much as 3/4 of the total supply. A new list of civilian products in which nickel cannot be used has been issued; it includes items like heating and cooking appliances, and refrigerating equipment. This will save some nickel, but not enough to relieve the shortage noticeably. NPA may soon put nickel on full allocation. Meantime, it plans a special allocation for makers of electronic receiving tubes, to keep them in business pending additional defense orders.

Manufacturers of electrical heating devices are a special hardship case, as there is no effective substitute for nickel-chrome resistance elements. They feel that nickel needed for 50 percent or more of the normal supply of nickel-chrome resistance elements could come from a relatively small cutback in stainless steel. Their point is that these items should not have to be in shorter supply than is dictated by the amounts of copper and steel available to go with them.

ALUMINUM LOOKS UP

Aluminum presents a somewhat brighter picture, at least to the electrical industry, because it can often be substituted for copper. Before Korea, we were using about 1,000,000 tons per year, about 600,000 of which was primary domestic production; 215,000 tons per year have already been added. About 150,000 tons more can be added to the domestic production rate during 1951 largely by the reactivation of idle facilities constructed during the last war. It is expected that capacity will be about 1,400,000 tons by the end of 1952, apart from foreign sources. Aluminum Company of Canada is planning a large new operation in British Columbia.

Thus, there was more than the mood of relaxation behind the 30-day postponement--from April 1 to May 1--of aluminum restrictions in more than 200 civilian products. Aluminum may actually be approaching a balance between use, as cutback by NPA orders, and supply. If military needs do not change, no further cuts in non-defense uses are foreseen.

PRODUCTION RATE
5 Times as Great!

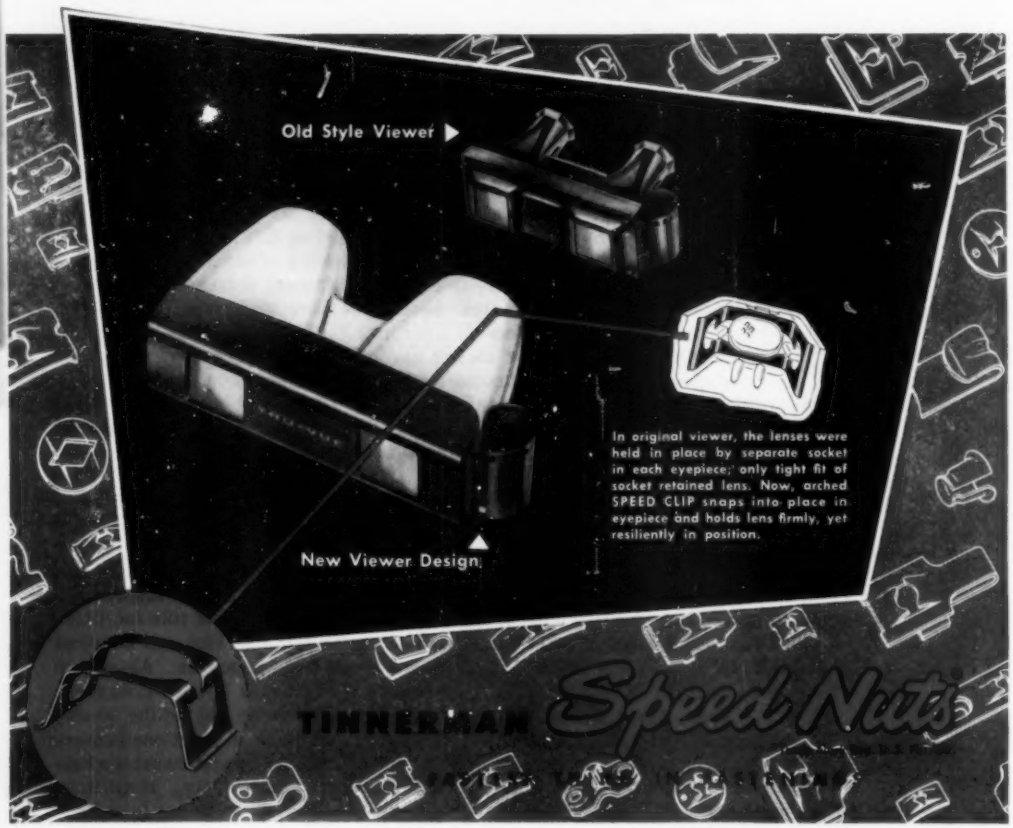
Reports TRU-VUE Company, Rock Island, Illinois

Production soared when SPEED CLIPS® were incorporated in the redesign of film viewer. Other immediate benefits: new beauty, new sales appeal were added to product; new safety-in-use provided.

The Tru-Vue Company recently put their film viewer through a complete redesign process. Out of this came a new method of installing lenses in the eyepieces. This vital product-improving design change was effected with "custom-built" SPEED CLIPS. The most important advantage was the simultaneous installation of both lenses instead of the one-at-a-time method previously used. Under actual assembly line conditions *this provided an increase in production from 400 units to 2,000 units per day!*

What's more, the design of the viewer was streamlined for greater eye appeal, and for more economical plastic fabrication. Also, the lenses were secure and safe—no chance for them to become dislodged or lost, as they did in the old style viewer.

All this adds up to real savings for Tru-Vue Company. Some of the same might be in order for *your* products. Find out the easy way—through a comprehensive Tinnerman Fastening Analysis. Sales offices in principal cities are ready to serve you—or write for details. TINNERMAN PRODUCTS, INC., Dept. 12, Box 6688, Cleveland 1, Ohio. In Canada: Dominion Fasteners Limited, Hamilton. In England: Simmonds Aerocessories, Ltd., Treforest, Wales.


Old Style Viewer
New Viewer Design
In original viewer, the lenses were held in place by separate socket in each eyepiece; only tight fit of socket retained lens. Now, arched SPEED CLIP snaps into place in eyepiece and holds lens firmly, yet resiliently in position.
TINNERMAN
Speed Nuts

Trouble Breeds Progress

We have it on the authority of one of the nation's leading milk vendors that contented cows give the best milk. But who wants to be a contented cow, or any other kind of a dumb animal? Complete contentment in any animal, including a human being, means stagnation. The world owes its progress not to those who passed through it always perfectly contented but to the men and women who were unsatisfied, dissatisfied or in complete disagreement.

The human race has always thrived on all kinds of troubles. And the number and importance of the new developments and the degree to which they were put to use, is a measure of the troublesomeness of the times. A chart of the progress of the world, spiritual or material, would also be a chart of the periods of peace and war. The greatest contributions to the world were made in times of greatest stress. He who delivered the Sermon on the Mount, and contributed greatest to all mankind, lived His life under the scourge of the Roman conquerers.

But even during times of peace and prosperity there are always individuals who are discontented with things as they are. We always have with us the constructive malcontents who are too often derided. We also have the scholars who thirst for more knowledge and the inquisitive ones who remain unhappy until they reach their goal. But in times of peace, as long as everybody else is happy, these "peculiar people" and the fruits of their labor receive little or no attention. In times of turmoil and war, they become the group to whom the nation looks for the basic scientific knowledge that will give it advantages over its enemy.

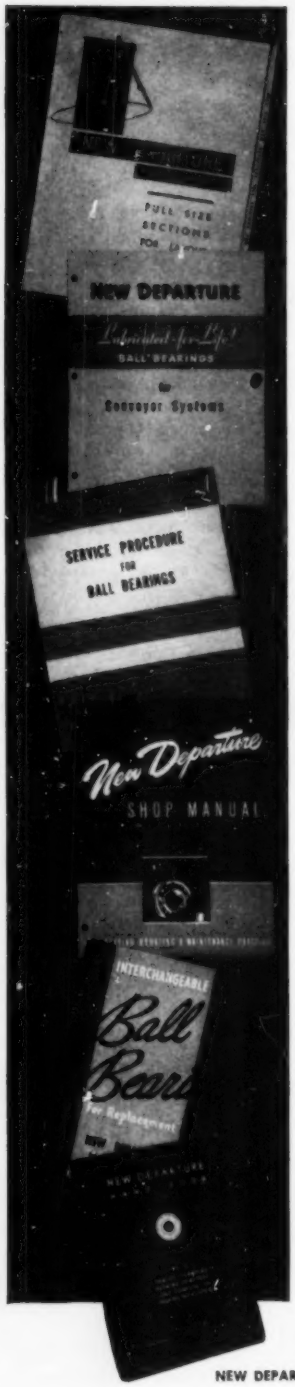
That is why in times of perfect peace and contentment relatively little is done to put to use the findings and discoveries of science. Only when times become difficult and problems multiply do we exploit science to its utmost. Acetylene, discovered late in the 19th century was virtually ignored except for its use in lamps, until World War I. It was not until World War II that it came into widespread use in industrial processes. Similarly, the airplane was merely a county fair curiosity until World War I impelled its development on an extensive scale. Jet propulsion, the gas turbine, radar and a host of other electronic developments can all be credited to the urgencies and troubles of the late war period.

After only a few years of peace a multitude of troubles are again infesting the world. Materials and labor shortages are merely one indication thereof. For the successful developments of new engines of war, new and better materials and alloys are needed. New fuels, greater power, higher speeds, and higher temperatures must be satisfied. Production machinery must be designed to run faster in order to produce more. Parts must be produced to greater accuracies. Thus the troublesome factors multiply.

Progress is measured by the speed and degree with which the problems encountered are overcome. On all fronts, politics, economics, international relations, medicine, pure sciences, technology and engineering design, troubles are breeding in abundance. And each new problem bids for the attention of specialists to solve it. By the speed and quality of the solutions we measure our progress and move on to a host of new problems to solve. We cannot afford to be like contented cows.

G. F. Rodenholt

Complete Information on Ball Bearings



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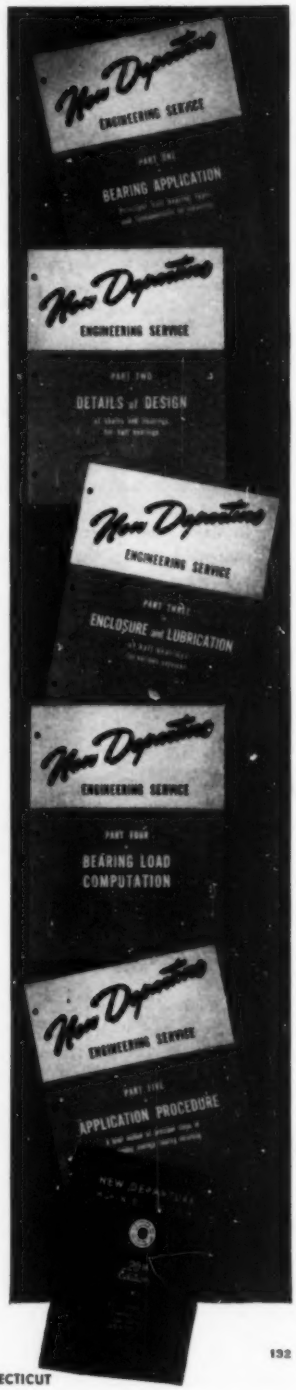
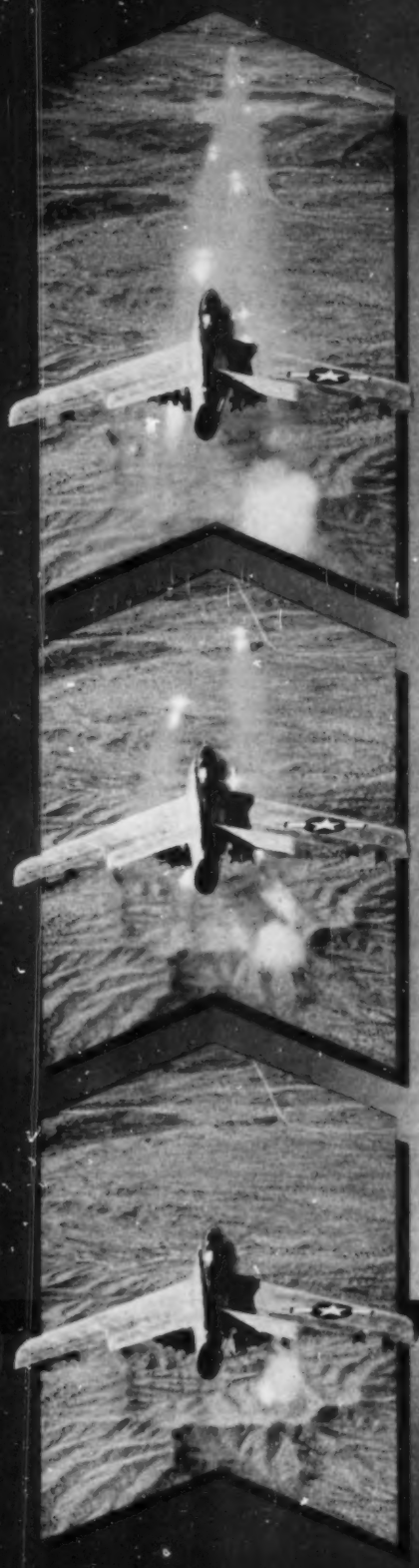


NEW DEPARTURE
BALL BEARINGS

Nothing Rolls Like a Ball

132

NEW DEPARTURE • Division of GENERAL MOTORS • BRISTOL, CONNECTICUT



DESIGNING FOR HISTORY'S DECISIVE DECADE

● Peace or war, the design engineer controls the fate of this country. It is he who must design the productive equipment to turn out products on a scale never before visualized.

It is he who must conceive and make possible the products manufactured on such machines.

● To assist the designer in achieving this end, Product Engineering herein evaluates recent significant developments in materials, hydraulic equipment, electrical and electronic equipment, design techniques, production processes, and mechanical parts — as well as salient trends in the design field.

It is these developments that will affect the design of products in the next decade.

F-84F Republic jet fighter makes a rocket attack on enemy ground forces

THE STATE OF THE ART IN *Design*

R. J. S. PIGOTT, Director, Engineering Division,
Gulf Research & Development Company

AT THIS TIME, when we may be again on the edge of a tremendous period of forced production, it may be wise to assess the "state of the art" in general design. Especially should we examine those paths that offer the best chance of rapid advancement.

Two major faults still exist in our technical approach to problems: (1) We don't examine what has been done well enough; and (2) we don't define the problem clearly and get down to basic principles in far too many cases. For example, Reynolds' contribution to fluid flow remained almost unused for better than 30 years, and it was nearly 50 before the full solution of flow in pipes, including roughness, was finally presented. In the ASME Fluid Meters Committee (1916), we found enough earlier material published to relieve us of doing any appreciable further research for seven years; we were busy digesting what had been done.

Twenty-five years ago an Australian, E. G. Herbert, found an easy way to get the temperature at the edge of a cutting tool. Today, about three groups in the United States have begun to employ the method in metal-cutting research.

With regard to mental approach, certainly we could save much time and money if the attempt to define the problem were undertaken at the beginning, thereby generally indicating the field of basic principles that must be investigated. For example, we are greatly elated to get commercial gasoline engines running at 7.5 compression on 90 octane gasoline. Yet, few remember that several designs of engine have been built (one or two about 30 years ago) that will run at 10 compression ratio, on 80 octane fuel. Nobody has defined quantitatively the features in engine design that affect its appetite for octane value. Is it hot valves, jacket cooling, piston temperature turbulence, intake temperature, manifold design, or what – and how much?

During the war we completely defined the problem of oil aeration and the cure. Similarly, with failure of fuel supply at altitude, at least 12 airplane companies and 3 engine companies conferred with Gulf Research and Development Company to get the full story, which is in all truth, extremely simple; but early this year one of these companies sent an engineer to get the solution of this same problem occurring with a recent engine built by one of the above 3 companies. What ails us? In the interest of common sense let us *read* the *record* and transmit old knowledge along the line so that we don't waste so much time and money retracing old steps.

Strides in Research

Research has taken tremendous strides in the last 20 years and is of unbelievable value when the so-called "practical" hunch method reaches its limit. But even research, to be successful, must still be based on ideas; you don't just turn the crank. One field that research has aided tremendously is that of instru-

ABOUT THE AUTHOR

R. J. S. PIGOTT is known and respected for so many reasons by engineers and close associates that selecting but a few of his accomplishments for a summary is an extremely difficult task. He has been Director of Engineering Research of Gulf Research & Development Company, a subsidiary of Gulf Oil Corporation, since 1929. His previous experience includes eleven years in the design, construction and operation of central steam power stations; seven years in designing and constructing industrial plants; and five years in the manufacture of metal products. He holds more than 30 patents on devices used in hydraulic engineering, heating, oil production, and instruments, and in 1946 Columbia presented him with the Columbia University Medal for engineering achievements.

His activities and accomplishments in various engineering societies have been outstanding. In 1950 he was President of the Instrument Society of America. He is a past President of the SAE, the only oil man to hold this office; and is a past Vice-President of the ASME. He was chairman of the ASME Special Research Committee on Fluid Meters from 1916-1946 and was responsible for starting this committee; and was a member of the main Power Test Codes Committee of the ASME and Chairman of the Definitions and Values Committee from 1918 to 1946.

The author of some 40 technical papers on power plant design, fluid flow, instruments, lubrication, superchargers, and other aspects of engineering, he herein presents some ideas on current problems in engineering and outlines some of the developments that hold promise for the future.

Aerial view of the laboratories of the Gulf Research and Development Company. Research may be defined as intelligent experimenting.

ments and tools for accomplishing jobs not so well done manually. The electron microscope has furnished us with a means of investigating powder metallurgy and paint pigments not possible with the optical microscope. In the case of greases it has shown the fibrous structure required to prevent bleeding and oil separation. The mass spectrometer and its associated X-ray instruments have opened a new field of chemical analysis not reached by microchemistry.

The oxide rectifier has changed the field of d-c current production, notably electroplating. Electronic controls for machine tools have opened many new fields, besides greatly raising production rates and improving accuracy. With computers and integrators, engineers can obtain solutions to equations in a matter of seconds, whereas previously solutions were impossible in a lifetime of work with paper and pencil.

Other developments in the electrical field that are still in the infancy stage of their application include thermistors, transistors and the germanium photocell.

Transistors, crystal amplifiers, can perform the same functions as vacuum tube amplifiers and are being used extensively in communications. Their life is practically indefinite.

Geophysical exploration has been greatly accelerated by the flying magnetometer, which can do up to 20 to 40 times as much work as crews on the ground; the worse the terrain – jungle or march – the bigger the difference.

Not Always Electronics

Electronics is of course getting the big play now, because it can be used to accomplish things not possible with other methods. But there are plenty of operations that can be done mechanically, pneumatically, or hydraulically. Just because electronics is relatively new and fascinating is no reason to use it for everything. The older methods are quite often simpler, more rugged, and cheaper. A few recent examples may illuminate the point.

The wall pressure of piston rings is a subject of importance in engine operation. One gage was developed using the air-gage principle. It could measure a load as well as a distance, and read wall pressure at 18 points in 15 seconds, correct within one percent accuracy. No other existing mechanical gage was within ±25 percent accuracy. One large government laboratory designed an electronic gage – it cost 3 times as much, is much slower, and has about the same accuracy.

The application of fiber glass and silicones to insulation has raised safe operating temperatures and consequently increased output of electrical apparatus. In addition, some of the silicones have been developed as valuable foam-suppressing agents in oils.

The foregoing illustrates very sketchily some of the things research has done. But it will be noted that research has contributed most largely to better development and to the tools we work with. Invention, distinct from research, is still required. Research cannot think for you; it can only provide facts and indicate the paths to follow. The piston ring gage mentioned above is an example; this device was invented, then research was applied to improve it.

Cutting Speeds Doubled

A still more recent case is that of the application of cutting fluids to metal cutting tools. For half a century we had been putting oil or other fluids on tools to get longer tool life or higher cutting speeds, the improvement being on the order of 50 to perhaps 100 percent. All the atten-

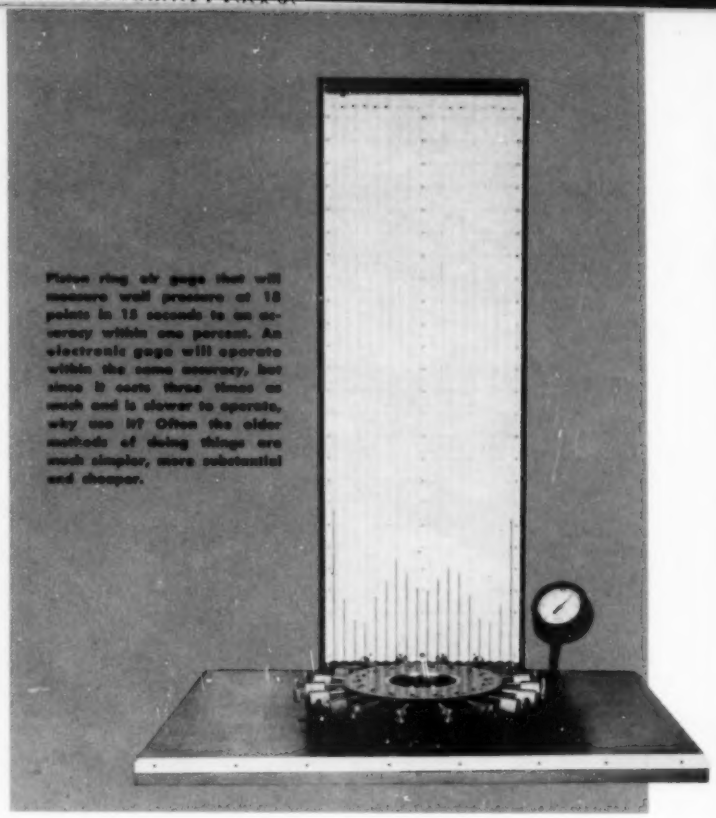
tion was on improving the fluids. Now with a new method of application the writer has produced tool life 5 times to as high as 20 times what we have been getting; or if needed, cutting speeds can be doubled with tool life remaining the same or somewhat more. At this point, research can go to bat on how best to apply the fluid and to determine the limits to which we can go. Further, the research on fluids will have to start over, as the required characteristics of the fluids are likely to be quite different from the present ones.

Looking Into the Future

At any rate, any good look at developments taking place recently, whether brought on by invention or research, will show that if we want improvements we must stop looking in the handbook and start to think, and to do a little experimenting. Our gains in design frequently come from invention-synthesizing by thinking – but the development, the improvement, of invention usually comes from research. And these two are mutual spark plugs – the research stimulated by an invention usually brings up new facts that can be synthesized into another invention, and so on.

Taking up the crystal ball, it is always a risk to prophesy what will happen in the future, in view of the rapid rate of technical change. It is certain that in production machinery of all kinds, from machine tools to reapers, the entry of research and automatic control will result in automatic operation and improve rate of output. The changes in close-tolerance repeat grinding as well as contour and shape making, already owe much to this type of development. There will be an accelerating use of pneumatic, hydraulic, and electronic controls; and as usual, it is likely that the automotive industry with its huge production will continue to energize this field of design.

In the field of internal combustion engines, it is now fairly well settled that octane value of fuels cannot advance further in any appreciable amount; therefore, if the advantages of higher compression ratio in economy and weight per horsepower are to be realized, the designer will have to do it himself, by reducing the engine appetite for octane value.

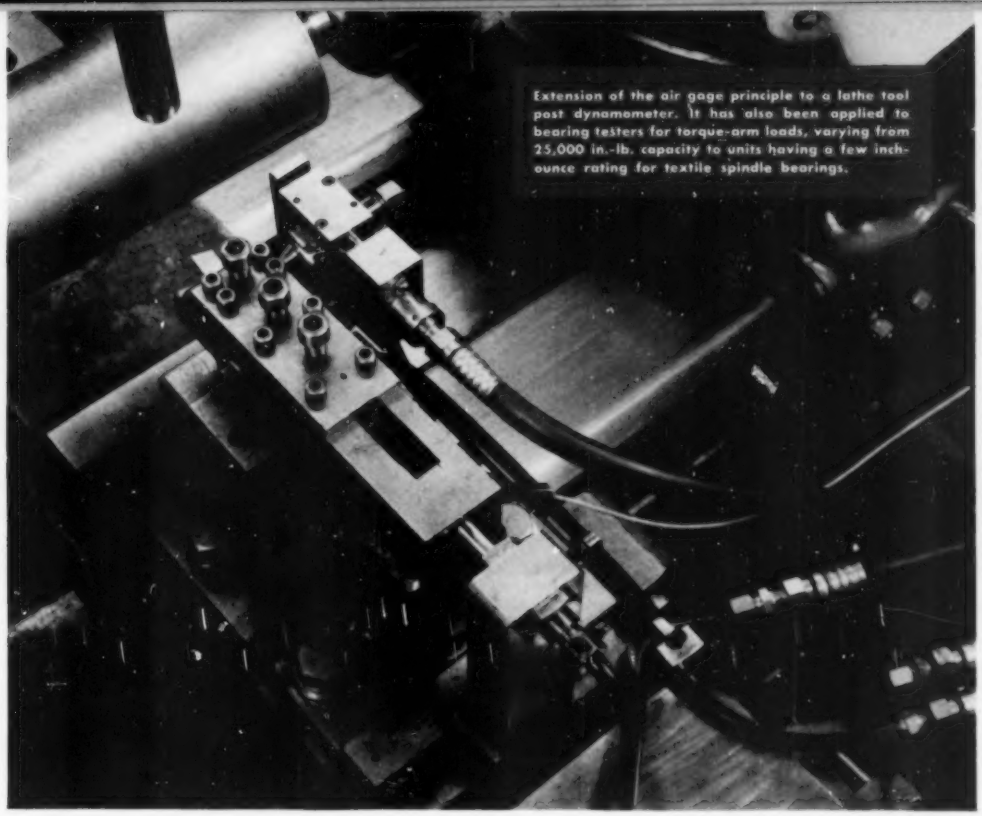


Piston ring air gage that will measure wall pressure at 18 points in 15 seconds to an accuracy within one percent. An electronic gage will operate within the same accuracy, but since it costs three times as much and is slower to operate, why use it? Often the older methods of doing things are much simpler, more substantial and cheaper.

The Diesel engine has reached into more and more commercial markets (now taking on railroad power), but as compression ratio rises, the gasoline engine keeps approaching it in economy. And in all cases the Diesel is more expensive per brake horsepower, and is heavier and bulkier than the gasoline engine. Its present rapid adoption for automotive and similar use is based on an economic situation that could be easily upset. Diesel fuel oil costs but little less than gasoline to make; but gasoline is taxed more than its manufacturing cost, and the sales price therefore is *widely* different. Should the government decide to tax Diesel fuel like gasoline, Diesel development would be seriously checked. In any case, however, it will continue to hold its place or gain in those power applications where weight and bulk are not materially deterrent – stationary power, locomotives, ships – and where large sizes are needed.

As to the gas turbine and when it can replace the reciprocating engine, the situation is dependent on one factor only – temperature. As a machine, its efficiency in use of its cycle is as good or better than the reciprocating engine now. But as yet no practicable way has been found to cool it, so the initial temperature of the hot gases is limited to the safe value for the materials we can use in the turbine – 1,500 F. But the temperature subsisting in the gasoline or Diesel engine is above 4,000 F, which means that the cycle efficiency for the engine is more than twice that for the gas turbine. Until some way is found to increase the usable temperature in the gas turbine about to that now commonly occurring in reciprocating engines, it will not replace them for anything but specialized uses. It takes twice as much fuel per brake horsepower-hour now. However, it does seem likely that someone will solve this problem in the next five or ten years.

Fuel supply has in the last few years been a widely disputed subject, particularly liquid fuels. The writer's own examination of the data leads to the belief that petroleum and natural



Extension of the air gage principle to a lathe tool post dynamometer. It has also been applied to bearing testers for torque-arm loads, varying from 25,000 in.-lb. capacity to units having a few inch-ounce rating for textile spindle bearings.

gas will last for a couple of generations and that synthetics can then successfully take over. We can make liquid fuel from any kind of cellulosic material such as timber, crop waste or peat, but up to now it costs two or three times as much as gasoline. However, technological improvements will undoubtedly lower cost, so that when synthetic fuels are really needed they can be economically employed.

The heat-pump cycle for heating houses is regarded by many as saving fuel; this is entirely incorrect. The system merely transfers the heat load from a fire in your house to one in the power plant and saves no fuel. But sunlight collection for heating is beginning to look practical; it requires a different architectural construction and a fairly heavy investment in equipment, but does save fuel.

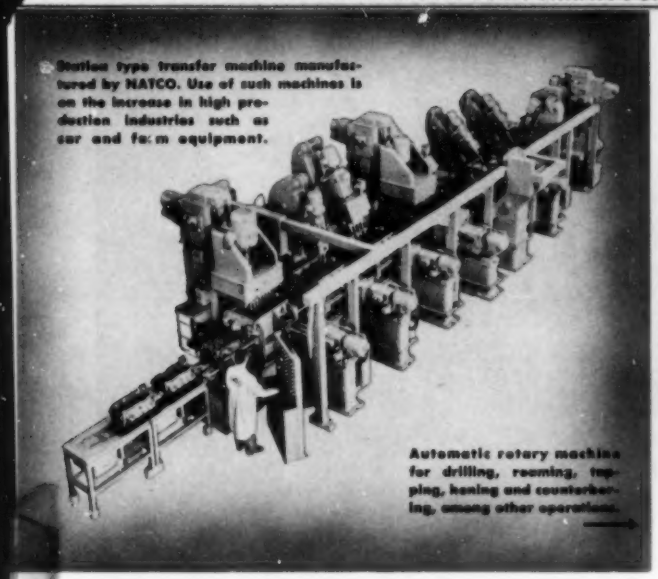
Another fruitful field for saving is in the automobile itself. This has an engine capable of 26 or 28 percent thermal efficiency, but the overall performance of the car is around 5 or 6 percent – may be a little better than a steam locomotive. We had better see what we could do to save that 30 to 50 percent loss of engine output that occurs between the engine flywheel and the surface of the road.

The foregoing statements of our present and possible future status is undoubtedly sketchy, but what the writer is really doing is needling the design engineer (including himself) into considering seriously some of those inefficiently solved problems.

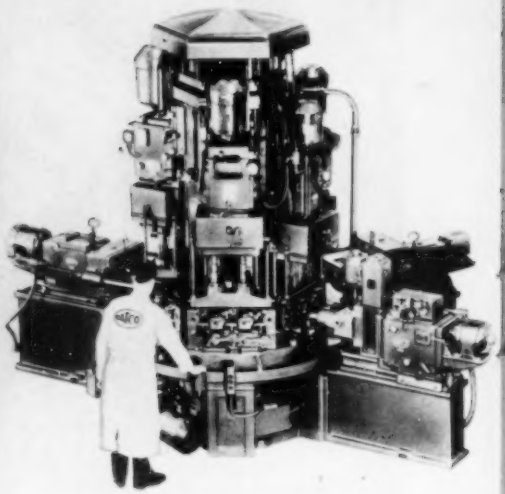
In the remaining sections of this special report, the editors of PRODUCT ENGINEERING have summarized and evaluated those developments and trends that now appear will have a significant effect on the design of future equipment. To simplify classification, this report has been broken down into the following sections: Design Trends in Key Industries, Developments in Production Processes, Developments in Electrical and Electronic Components, Growth Industries of the Future, Design Activity in Foreign Countries, Developments in Materials, What 80 Major Companies are Doing Today, Developments in Power Transmission Devices, in Mechanical Parts, and in Hydraulic and Pneumatic Equipment.

It is, of course, impossible to include all of the data on all developments, but the information that has been gathered should provide a nucleus around which designers can build a fund of knowledge that will not only prove invaluable in the solution of everyday problems, but it is hoped, will stimulate their thinking and accelerate the adaptation of both old and new ideas in new and different ways.

General Eisenhower, in his first report to Congress following his assignment as Supreme Commander of the North Atlantic Unified Defense Forces called this our "decade of decision." For the designer, even more than the average man, those words are prophetic.



Station type transfer machine manufactured by NATCO. Use of such machines is on the increase in high production industries such as car and farm equipment.



Automatic rotary machine for drilling, reaming, tapping, honing and counterboring, among other operations.

Design Trends in Key Industries

New developments and trends in a particular industry may have a significant effect on the design practices in others. Summarized on these pages is the current design trend outlook in eleven major industries.

In MACHINE TOOLS . . . Automation Higher operating speeds . . . Easier maintenance

In few types of equipment has the trend toward labor saving and higher operating speeds been more pronounced than in machine tools. Increased labor rates, greater costs all along the line, and the continued improvement in carbide cutting tools and automatic control equipment have accelerated this trend.

One of the most significant swings is to station-type machines of the transfer type. These can be in-line machines, as used for engine blocks in the automotive industry, or rotary or even square types. Perhaps more common is the dial type machine that returns the part to the starting point on completion of the cycle past the various machining heads. About one-third of the machine tool builders are building special machines.

Along with station equipment has come automatic loading and unloading devices so that the operator does not pace the machine and limit the output. Labor, of course, is opposed to the installation of such equipment and would like to find ways to hold down the output. The designer must anticipate this problem and take it into account when designing not only the machine but jigs and fixtures as well. If possible, automatically cycled clamping and unclamping mechanisms should be incorporated in the machine.

Higher Cutting Speeds

To approach the optimum in machinability, cutting speeds will be increased. The machinability studies started at Ford under a developmental Air Force contract and continued by Hurley at Wright Aeronautical Corporation proved this. The report on the results of this investigation (see AMERICAN MACHINIST, Nov. 27, 1950) established the microstructure rather than composition as the governing factor on machinability.

Using this data, Ford production specialists studied the manufacture of a rear-axle pinion, with the result that they now have two high-speed single-spindle automatic lathes that have replaced 17 machine tools, eleven of which were prewar multi-spindle units. These lathes, which probably cost upward of $50,000 per machine, operate at a speed of 1,005 rpm and a feed of 0.0148 in., and have one tool operating at a speed of 825 fpm. Unit costs on these pinions have been cut by 65 percent.

With machine tools operating at these speeds, chip disposal becomes a problem and because of the heavy loads and high speeds, hardened bearings, special motors, and shaved and hardened gears must be used. Modification of existing equipment is not satisfactory, and the machines must be designed from the ground up. The first model always requires extensive test and change, and on one machine, the design of a supporting member was slightly changed to minimize vibration. Especially is the problem of chip disposal difficult, and it is doubtful if the machine tool manufacturers have given enough thought to this problem. Several high speed machines have not proven out because chips piled up and there was no way to get rid of them. On another machine, the fixture had to be machined out to provide a passage way.

Coming: – More developments in electronic controls and new coolant methods to increase cutting speeds.

Improved Maintenance

Within the past few years, machine tool users have organized several standards groups to write specifica-

tions that would improve ease of maintenance. Notable are the JIC hydraulic standards (see HYDRAULICS) electrical standards, and packing standards. Not even the most enthusiastic supporters of these programs looks upon them as the panacea of their problems; nevertheless they do represent an excellent beginning. Even more emphasis can be expected on provision for maintenance in the design of future equipment with standardization a factor.

The Answer: More Cooperation

The big market in machine tools will always be the general purpose unit. But whether designing general purpose or special equipment, the designer will have to become better acquainted with the requirements and problems of the using manufacturer. This means that machine tool builders will have to sponsor greater cooperation between the designer, production man, and metallurgist.

In the CHEMICAL INDUSTRY... Higher pressures... Higher temperatures... Computers for process control

High pressure can mean almost anything. In aircraft hydraulic systems, it means 3,000 psi; in steam generation, it means 750 to 1,500 psi. But in the chemical industry it is beginning to mean operating pressures of from 10,000 to 50,000 psi.

There are two good reasons for using high pressure for certain reactions: Reactions can be obtained that would otherwise be impossible; and the efficiency of the reaction is greatly increased. Perhaps the widest use of high pressures is made in polymerizing ethylene to obtain polyethylene; DuPont has a plant operating at 50,000 psi. DuPont also is researching processes requiring pressures from 3,000 to 30,000 psi, as is Hercules, American Cyanamid, Union Carbide and Carbon, and many others.

During the last war, high pressure hydrogenization of coal received great impetus. Two years ago, the Bureau of Mines opened a coal hydrogenization plant at Louisiana, Missouri, and while still expensive, the Bureau of Mines is optimistic about its potentialities.

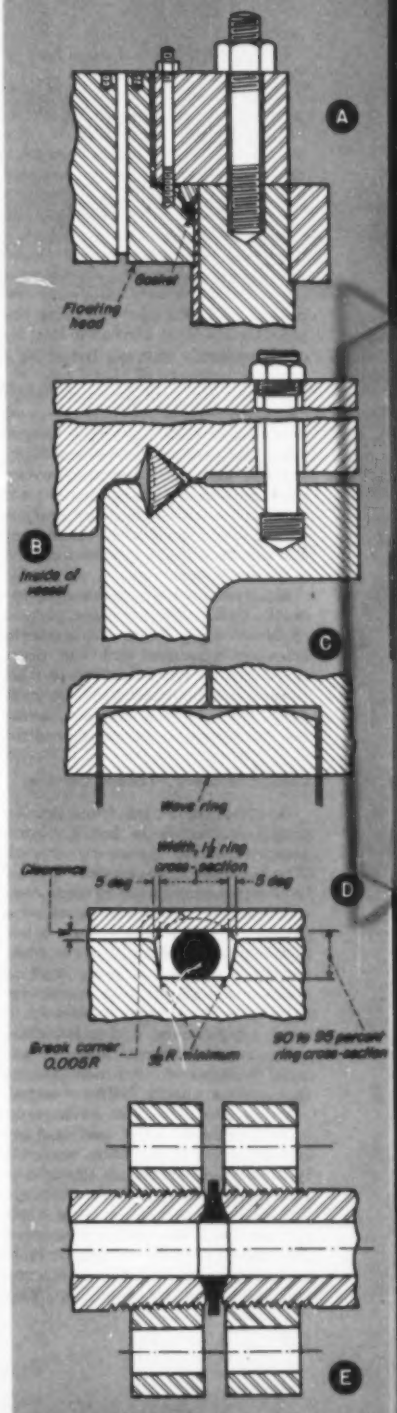
In the design of equipment for high pressures, selection of materials, vessel construction, gasketing, and valving require special attention (CHEMICAL ENGINEERING, August, 1949). Some of the constructions used in this type of equipment have possible applications in other fields such as hydraulic power transmission or steam generation.

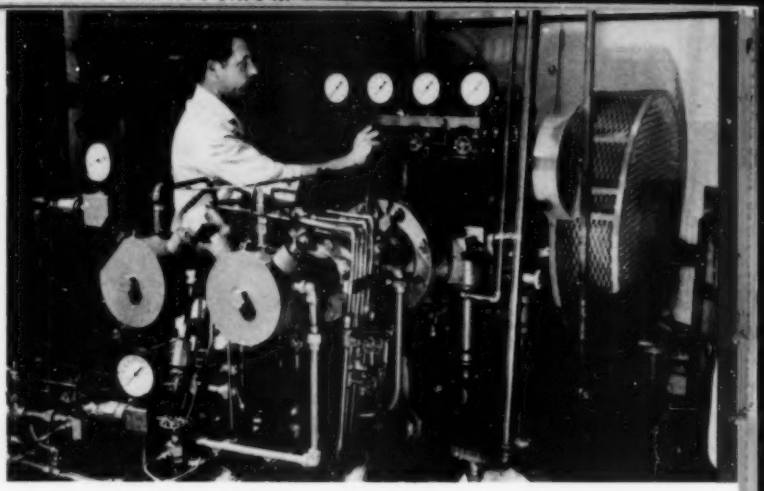
For example, different constructions used for high pressure vessels are listed in the accompanying table. Of these, the first three are used extensively in this country. The last, a construction developed by the Germans and generally known as a Wickelhofen construction, is now be-

Pressure Vessel Construction

TYPE	RELATIVE COST	REMARKS
Forged and machined from solid stock.	Believed most economical above ratings of about 7,000 psi in smaller sizes.	Limited in size by capacity of forging equipment available. Used extensively for small vessels. Classical design methods satisfactory.
Rolled and welded of heavy plate.	Generally best below 4,000 psi (based on economics and pressure ratings).	Somewhat limited by strength of weld although this has proved no major obstacle. Limited more by thickness of plate that can be formed.
Successive cylinders shrunk on one another or built up in layers and welded.	Probably most economical in 5-6,000 psi pressure range and above when size of vessels is above 100 T.	No limitation on vessel size. Successive shrinkage stresses vessel so that all layers except last are in compression; thus in theory, thinner wall construction is possible.
Inner cylinder wound with successive layers of wire.	Have not been too successful so far and seldom used.	
Inner cylinder wound with layers of steel tape.	Unknown, although would probably compete above the 5,000 psi pressure range.	So far only Germans have manufactured in any quantity. Vessel prestressed by heating tape as it is applied, the drop in temperature on cooling stressing the wall.

Closures and gaskets for high pressure vessels: (A) Bridgemen type for large vessels; (B) less expensive delta gasket for large vessels developed by DuPont; (C) wave ring, which is popular in England for piping and small vessels; (D) O-ring seal; and (E) lens ring, used by the Bureau of Mines in coal hydrogenization.





Six-stage compressor in the high pressure laboratory of the Hercules Powder Co., Wilmington, Del. The unit has a maximum intake capacity of 30 cu ft min and a maximum delivery pressure of 10,000 psi.

ing tried out. The sketch shows the basic construction of this type of vessel.

Gaskets and closures used for high pressure are of several types (see accompanying illustrations.) The Bridgeman type is costly because of the precision machining required, and under extremely high pressures, the gasket may extrude into the space between the wall and the head. The delta gasket, on the other hand, results in a somewhat less expensive closure. One gasket, made of annealed SAE 1035 steel and being approximately ¾ in. across the long leg of the triangle, was designed for a working pressure of 12,500 psi.

Valving for high pressure equipment also must be specially designed. The tendency is to use highly alloyed materials such as Stellite and Kennametal for outlet nozzles, vanes, seats, and other parts subject to wear and errosion. For high pressure – above 5,000 psi – bodies are forged and the valve is of angle construction to minimize wear.

Materials for high pressure equipment, particularly vessels, are a problem since high temperatures often are coincident with high pressures. Temperatures of 4,000 to 4,600 F have been encountered. For these temperatures, fused stabilized zirconia refractories hold great promise.

Computers for Process Control

Another significant trend in the chemical industry is that involving computers for process control. Whether these devices should actually be termed computers or high-level servomechanisms is somewhat of a question, but the terminology is beside the point. Actually, these computers or servos are being used to measure the quality of a product, to determine the changes necessary to meet specifications, and to automatically regulate temperature, pressure, mixtures or other quantities so that uniform quality will be obtained.

There often are other advantages, namely reduced labor cost and increased safety of operation, especially when the reaction is dangerous. For example, the methyl methacrylate process used in making clear plastics such as Lucite was once abandoned because it was unstable and dangerous. With computer controls, it is now in production. This field, not of automatic controls but of computer controls, is just beginning to be explored on a large scale. The question of whether to use them or whether to rely on manual operation is, of course, one involving not only equipment but economics as well.

Most processes require little manpower for supervision, so labor saving is often not a big factor.

In COAL MINING EQUIPMENT . . . Automatic mining machines . . . More conveyor belts . . . New strip mining equipment . . . More mechanical cleaning

Despite opinion that is frequently to the contrary, the coal industry is extremely active in the design and development of new equipment. Current emphasis is on machines to reduce the amount of face labor required per ton of coal mined – the amount of labor directly involved in the mining operation – and on better cleaning of the product, with emphasis on the fine sizes.

A definite trend is the use of electric power to dig coal out of the solid. It is the principle used in all automatic mining machines today. Instead of undercutting, drilling, blasting and loading, as was the former sequence of operation, these mining machines cut the coal out of the seam, pick it up on a conveyor and load it on cars. There are perhaps a dozen machines under development, with at least three in actual commercial operation:

1. The conventional type looks something like an ordinary loader except that it has cutting tools or boring equipment on one end supplemented by equipment for picking the coal up and conveying it to the transportation unit.

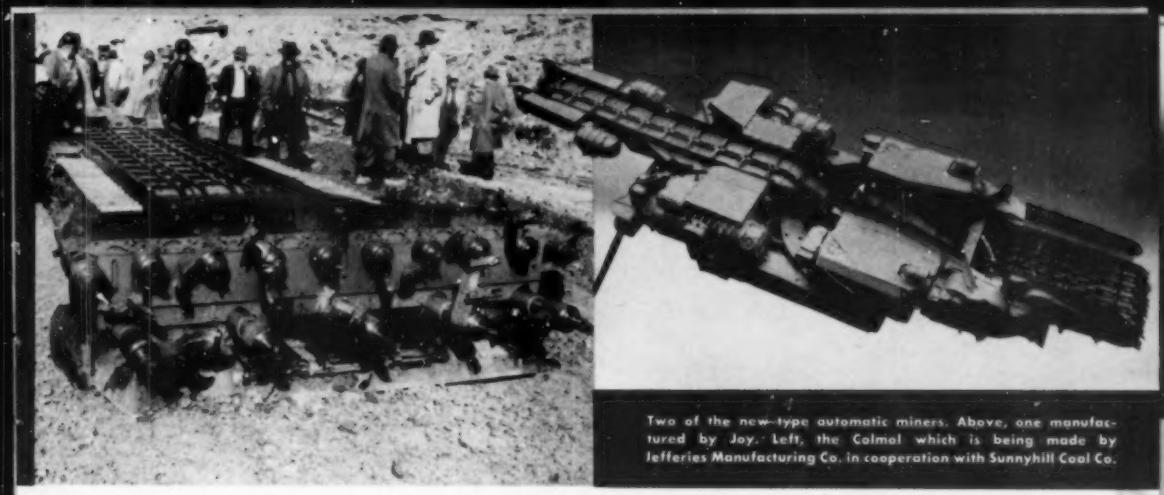
2. The big auger is simply what the name implies – an auger of 2 to 5 ft in dia and usually six feet long and able to bore 100 ft or more. The augers are sectionalized for easy handling. Sections usually are 6 ft long. Some mines have used augers up to 180-190 ft long successfully. This machine is attracting considerable interest in this country.

3. The planer-type machine includes a cutter that planes the coal from the face of the seam. So far none of these machines are in operation in this country, but several European countries have them in successful operation.

Shuttle cars and mine locomotives are electrically powered in the U. S. In the case of shuttle cars, many run on storage batteries with a 350 amp-hr capacity or greater. Small diesel engine driven generators, used in conjunction with much smaller batteries–say 100 amp-hr–are a definite possibility. Diesel mine locomotives have yet to be used by coal mines here, although they are in service in Great Britain and Australia.

There is a trend toward the use of a-c for underground mining equipment, particularly in all conveyor mines which are increasing in number. When d-c is required, selenium type rectifiers, now available in 25, 37½ and even 50 kw capacities are increasing in popularity for power conversion.

In stripping operations, the big



Two of the new-type automatic miners. Above, one manufactured by Joy. Left, the Colmol which is being made by Jefferies Manufacturing Co. in cooperation with Sunnyhill Coal Co.

walking drag line is increasing in number. Shovels have yet to be counted out of the picture, however. Buckets have reached 50 cu yd capacity, and some thought is being given to 60 yd units. Whether a shovel or a drag line is used, however, the problem is to get the coal away from point of operation. One possibility is a stacker that would grind the coal from the bucket and load it on a conveyor belt or on a rubber-tire train. Of course, the problem is to build a crusher big enough to take 60 cu yd in one gulp and to grind it on a 60 sec cycle.

Right now in stripping operations, 70 ton semi-trailer trucks are standard transportation in many mines. These units are pulled by tractors with 400 hp diesel engines and torque converter drives. Also, auger mining machines were pioneered in strip mines and still are in operation; whether their use will be expanded is a matter of opinion.

Finally, in underground mines the following trends can be listed:

1. Conveyor belts are getting bigger and longer, and are being designed for bigger capacities.

2. Roof bolts, either of the spread type or expansion type, are proving the answer to roof-support problems.

3. Plastic films, such as used to mothball military equipment after the last war, have been found to provide excellent sealing of ventilation stoppings to reduce air losses, and an excellent means of preventing crumbling of mine roofs.

4. Equipment for fine coal treatment – washing tables and dryers – vacuum, heat, or mechanical – as well as heavy media and flotation cleaning equipment is receiving considerable attention. This trend extends to all types of mining.

In the RAILROAD INDUSTRY... New power sources ... Lighter constructions ... Unit cars

Designers are still far from satisfied with the power source at the head of a train. Steam locomotives have been the standard, but new orders on such equipment are practically non-existent; diesel electric units have taken over the industry. While these represent a major improvement, other types are also under development.

Electrical drives, of course, are the ideal form of motive power for locomotives. With them, high starting torque, sustained operation at high speed, individual drives for wheel pairs, and adjustable speed from stop to maximum rating can be obtained. Maintenance on the electrical system also is low. Therefore, the locomotive of the future will probably be electrically driven. The unknown quantity is the form of drive for the generator.

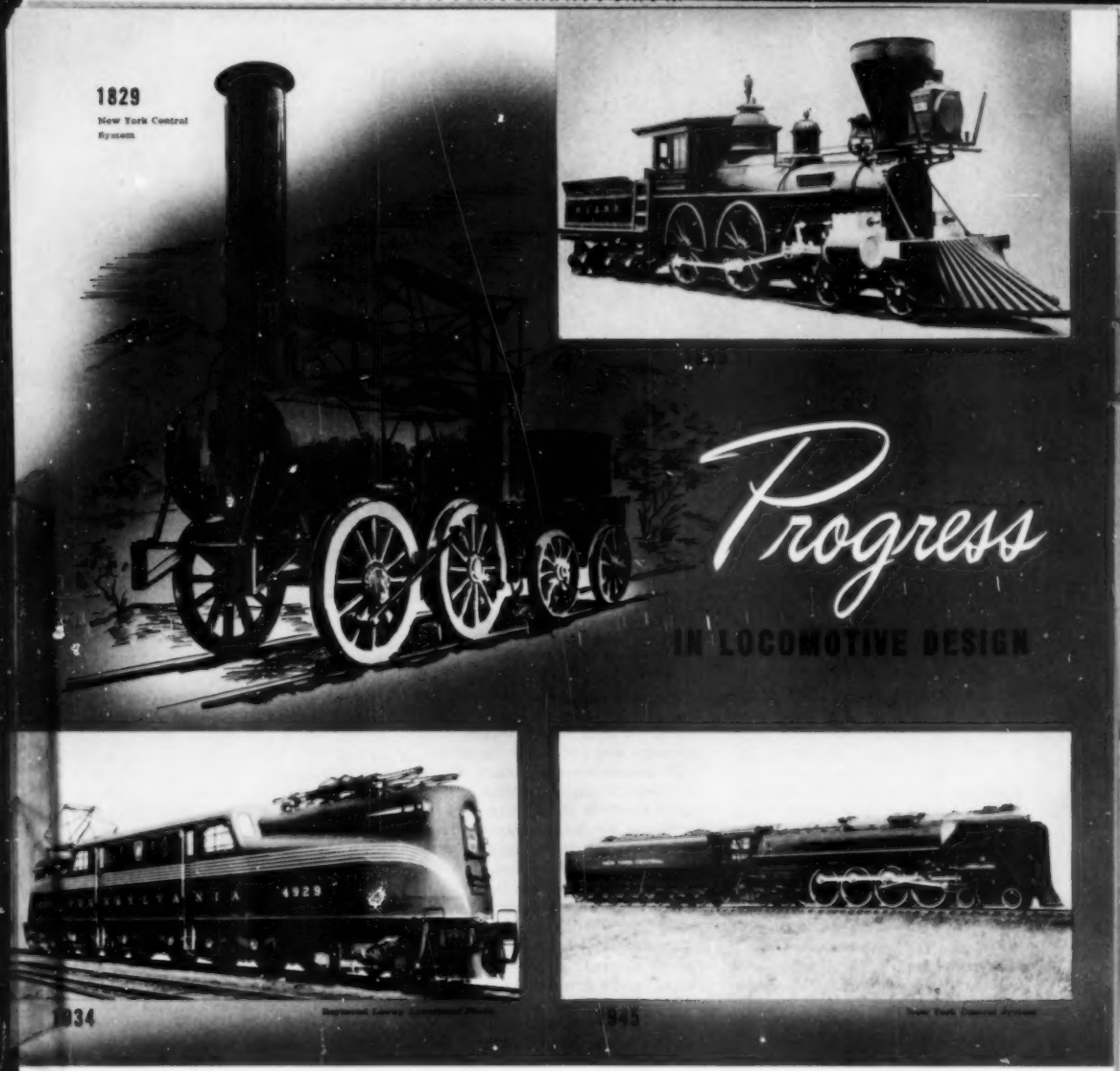
There are several possibilities: the gas turbine, either oil or coal fired; the steam turbine; and the ignition locomotive. (See next pages.) The B & O has had three steam-turbine electric locomotives in passenger service now for some time. They have proven satisfactory. The disadvantages are that (1) first cost of the units is high; and (2) fire must be started in the boiler some time before the run to generate a sufficient head of steam.

At the moment, the gas turbine electric locomotive appears to have a bright future. Allis-Chalmers has completed delivery of their coal fired gas turbine, but it has not yet been installed in a locomotive; and Westinghouse has an oil fired gas turbine locomotive in experimental service on the Pennsylvania. GE seems to be further ahead: With over a year of experimental long haul freight service on the Santa Fe on one oil fired gas turbine unit, GE is getting ready for large scale production. The Santa Fe alone has placed orders for twenty locomotives and several other roads would like to get at least one.

Another development that is attracting some attention in railroad circles is the new Budd RDC – railroad disel car. Powered with two 275 hp 4 cycle diesels, one for each truck, the car is direct driven through Allison hydraulic torque converters. Both engines are mounted in the center of the car, one driving to each truck.

Although the unit car has never proven too popular in this country, some railroad people believe that it represents one answer to bus competition. Operation is economical, the car can be driven in either direction, several cars can be coupled together to form a train, and fast service can be maintained between operating points. Other car builders are watching Budd's progress closely.

All railroad rolling stock has, of course, undergone a revolution in the past several years. Roller bearing wheels, better truck suspension and extensive use of lighter and stronger material – low alloy steels, stainless steel and aluminum – have been used for passenger cars and to some extent for freight cars. For electrified service, Westinghouse believes that the ignition locomotive has possibilities. It would permit power line transmission of a-c, which would be converted to d-c for adjustable speed drive with d-c motors.



NO PRODUCT tells a more complete story of engineering evolution than the locomotive. Every branch of engineering in every decade contributed something. It is certain that after History's Decisive Decade, more testimony to the ingenuity of product engineers will be added to this pictorial record.

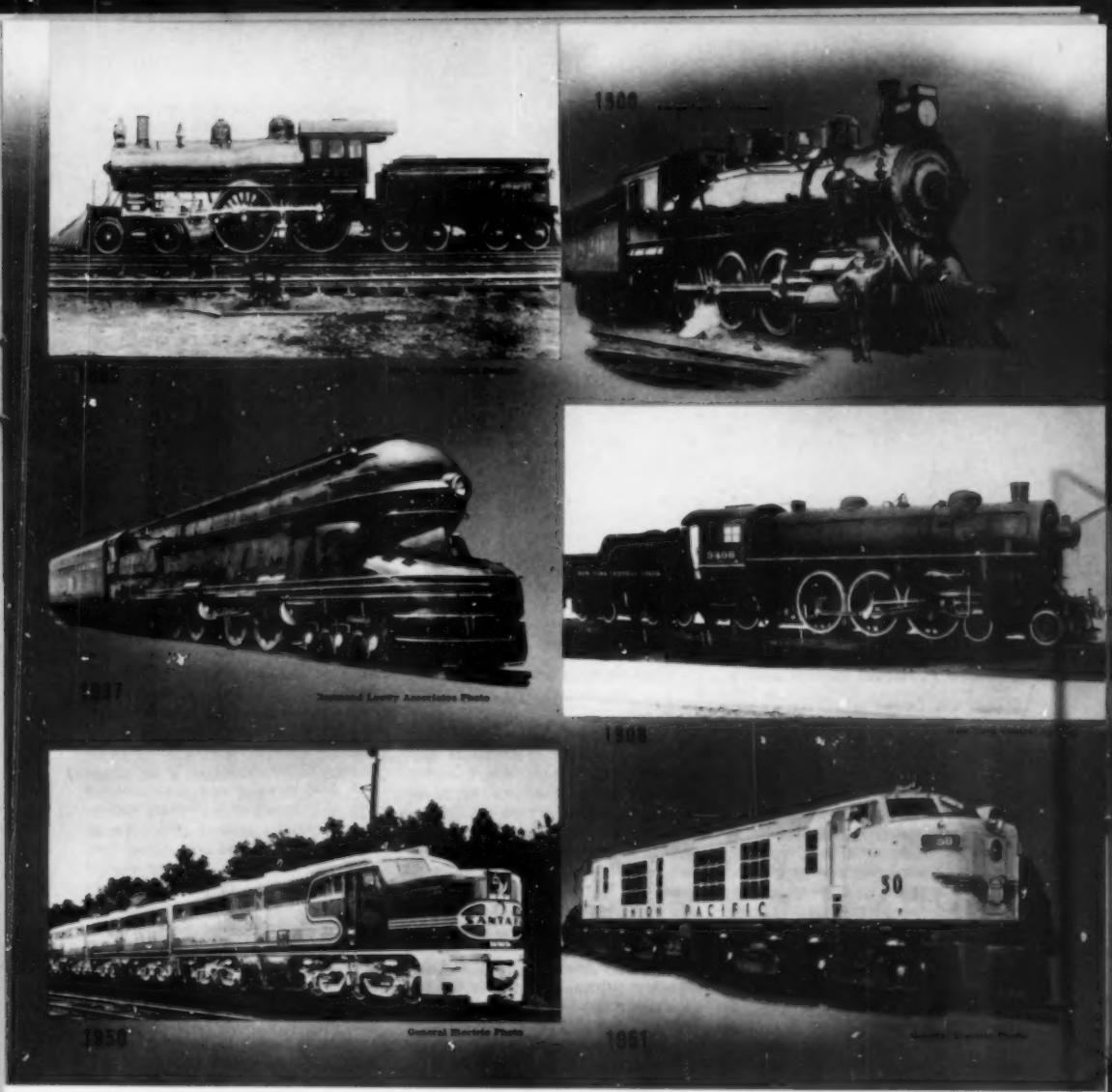
1829 "Stourbridge Lion" was first steam locomotive operated in America on a commercial railroad. Weight was 8 tons; tractive effort – 2,000 lb; boiler pressure – 50 psi. Note walking beam drive.

1855 saw larger locomotives like the 70 ton "General." Boiler pressure was up to 140 psi and drivers were 65 inches in diameter. Wood was fuel used, as evidenced by the funnel-shaped smokestack.

1893 Famous "999" locomotive set a record of 112.5 mph, high even for modern trackage. Most later design efforts were concentrated on raising the ratio of horsepower to weight rather than speed.

1900 Classic lines of the Union Pacific "1820" are typical of many steam locomotives still in service. Boiler operated at 165 psi. Top speed was 60 mph with drawbar pull of over 21,000 pounds.

1908 The "Pacific", developing 1,635 hp at 40 mph, marked end of an era in locomotive design. Since rails were already stressed to the limit, engineers could not get a more powerful locomotive simply by making it bigger. New materials and thermodynamic techniques solved the problem in later designs.



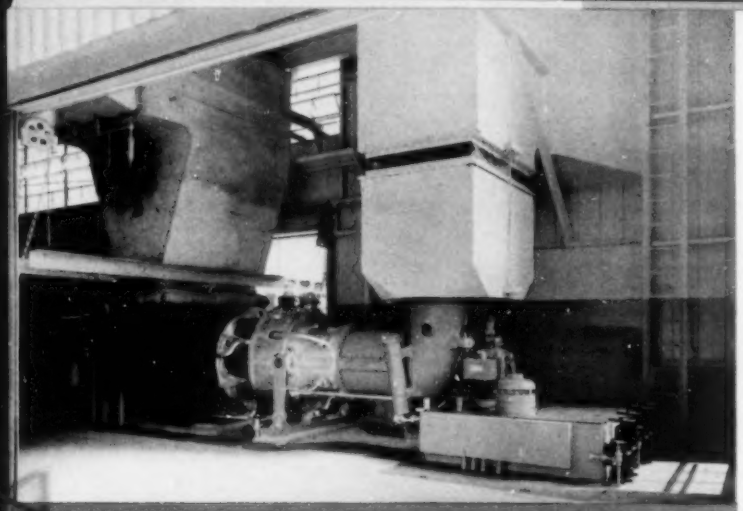
1934 Electric locomotives, first tried out in 1895, are superior to any other type in respect to efficiency and performance. But the cost of railroad electrification – power lines and substations – has become prohibitive. Shown is 5,000 hp, 90 mph plant.

1937 Streamlining became a part of steam locomotive design. Pictured is the Pennsylvania Railroad's SI type styled by Raymond Loewy. Wind tunnel tests showed this locomotive to offer 33 per cent less wind resistance than non-streamlined version.

1945 Just before succumbing entirely to diesel-electrics, steam locomotive design reached the peak in respect to horsepower output per pound of weight. The "Niagara" type weighs over 138 tons, delivers 4,850 drawbar hp at 65 mph. Design features include fire tube boilers; roller bearings for all wheels and drive rods; extensive use of high tensile, silicon steel for weight reduction. Boiler pressure is 290 psi.

1950 Although introduced in 1924, diesel-electrics did not become universally popular until 1946. Then the swing to diesel-electrics was abrupt. Today manufacture of steam locomotives has virtually ceased. Shown is Alco-GE 6,750 hp, locomotive.

1951 The gas turbine-electric locomotive is already past the field test stage. Using a power plant similar to an aircraft turbojet, the 4,500 hp locomotive is shorter and lighter than a diesel-electric of equivalent output and can burn cheap grades of fuel.



One of the new trends in power is stationary gas turbines for electric power generation or for pumping service in gas lines. Illustrated is the G-E 3500-kw gas turbine generator set at Arthur S. Nesy Power Station of the Oklahoma Gas & Electric Co.

In POWER GENERATION and DISTRIBUTION . . . Larger turbine generators . . . Gas turbines . . . High voltage distribution

Behind the development of larger and more efficient power generating equipment is the common denominator of most engineering progress: Better materials. This applies to the drives for generating equipment, to the generating equipment itself, and to the assorted devices and equipment used for distribution. The result: bigger and more efficient equipment. Insofar as conventional power generating units are concerned, this progress is not spectacular. Rather, it represents a gradual, long-range, yet significant improvement in design.

But there are some new ideas and devices currently being explored for the first time on any practical scale. Such devices include stationary gas turbine driven generators, atomic power reactors for shipboard and aircraft use, and high voltage distribution lines (500,000 v).

First for the gradual improvements and trends. The size of high-speed 3,600 rpm turbine generators for power plants has steadily increased. A 100,000 kw, 3,600 rpm single shaft machine is now common, and several units of 150,000 kw capacity have been built. These machines operate at a top temperature of about 1,050 F and a pressure of 1,800 psi. Larger machines are already projected and designers feel that an increase in temperature to 1,100 F is entirely practical even with the additional creep that can be expected at such temperatures. The result will be that these machines, which will carry the base load, will increase in thermal efficiency by about ½ percent, thus helping to partially offset increased fuel, maintenance and equipment cost. This trend is primarily the result of better high temperature turbine materials and of gradual improvements in the generator design. No major changes in design or design techniques – except for the use of digital and analog computers to improve calculation speed and accuracy – have been necessary for such large units.

In the auxiliary power field, turbines are being packaged as a unit with the oil reservoir, supplemental gearing, and the driven equipment on a common bedplate. With developments and refinements in gearing, much of which has been learned as a result of gear design for gas turbine-propeller driven aircraft, these turbines can be designed for rotational speeds up to 5,000 rpm in capacities of 1,500 kw.

In the gas turbine field, this country is taking steps to catch up with the Swiss, whose experiments in the 1930's with stationary equipment as well as gas turbine-electric locomotives have up until now put them far ahead of us technically. Even so the Swiss firm of Brown-Bovari probably has more know-how than we as of now. Within the next few years, many industry observers believe that situation will be reversed.

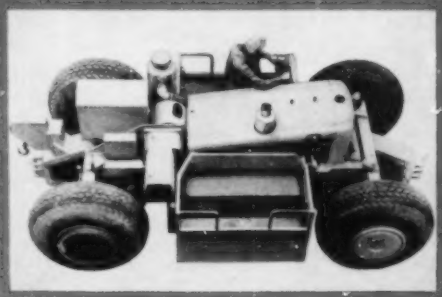
America's first commercial gas turbine power unit, the Belle Isle Station of Oklahoma Gas and Electric Company has been in operation now for over a year; it burns natural gas and operates at an initial temperature of 1,300 to 1,400 F. A unit at the Farmingdale Station of the Central Maine Power Company, which is rated at 5,000 kw capacity, operates on bunker *C* oil, and still another burning natural gas is in experimental gas line pumping service at Wilmar, Oklahoma. These successful applications, plus the development of gas turbine-electric railroad motive power (see Railroad) indicates that gas turbine driven equipment is just on the threshhold of commercial application.

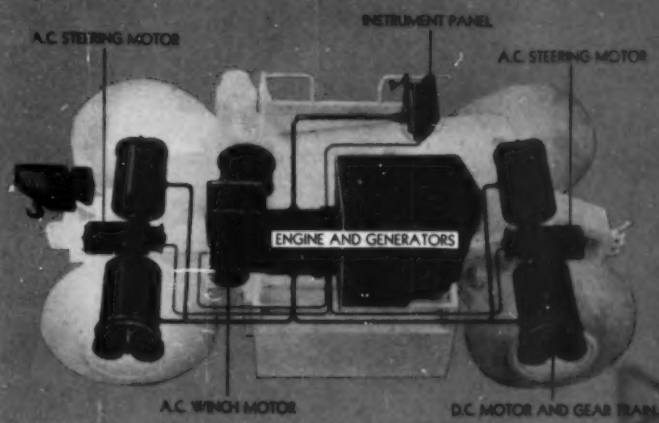
In the field of steam generation, the question in everyone's mind is the practicability of nuclear power reactors. Two attacks are being made on the problem – both military. The Nepa project, an attempt to develop an aircraft reaction, has been active since before the end of the last war; it was being worked on jointly by Fairchild Aviation and the Atomic Energy Commission.

A few months ago that contract was terminated with the announcement that the project had gone as far as possible and was completed. This did not mean that an atomic engine for aircraft was in existence. Fairchild was to work only on the theoretical problems.

Since then another contract has been given to GE for design and construction of an engine. Again, this is no indication that a reactor is practical for such application, since the contract is of a developmental nature. Also, most observers feel that initially at least, such power plants will be restricted to pilotless aircraft or guided missiles and not to conventional planes. The problem is not one of a reactor primarily but one of shielding. A piloted plane would require a greater weight of lead shielding than the weight of the reactor. In any case, this type of power plant must, if put on a piloted plane, go on one of large size, and actually any developments along these lines are still in the discussion and theory stage.

The other projects being worked on are aimed at nuclear power submarines. Westinghouse is working on this in Pittsburgh, and General Electric at the Knolls Atomic Power Laboratory outside Schenectady. With





The Tournatow, or "electric wheel," consists of a diesel engine driven generator and individual d-c motor drives for each wheel. When used to pull auxiliary equipment, booster power can be supplied to motors on the wheels of such vehicles.

these, as with all atomic projects, those who know the status cannot talk, but if advertisements by Westinghouse for design engineers for this project are any indication, the activity is intense.

Because of the accelerated military program, direct work on reactors that might have peacetime potential has been put aside. The only project having any peacetime possibilities – one of the four projected reactors at the Knolls Laboratory of GE – has been dropped so that GE scientists could concentrate on a nuclear-powered submarine.

Various proposals that private industry finance and build a nuclear power plant still are being studied, but the only one approved to date has been the small (10 kw) reactor at the University of North Carolina. About three years ago, one noted scientist stated – not for publication – that if half the effort and money were put into peacetime uses of atomic energy as were put into development of the bomb, nuclear power plants would be in existence within five years. The chances are good that certainly within the next decade, atomic reactors will be operating in this country.

High voltage distribution systems, research on which has been conducted by Westinghouse in conjunction with American Gas & Electric Service Corp., are being projected in the 500,000 volt range. One experimental installation at this voltage at the Tidd Power Station on AG & EC is being analyzed, and a 315,000 volt line is currently being constructed on the system of this company.

In CONSTRUCTION EQUIPMENT . . .
The electric wheel . . . Both specialized and universal equipment . . . Small portable machines

The construction industry does not rate the capacity of equipment in terms of size. Rather, the rating is based on the amount of material that can be handled per unit period of time. Thus, while one trend in construction equipment is to greater capacity, the result may be achieved by greater maneuverability, improved ease of operation, faster operation, or increased size. For example, one manufacturer – Euclid Road Machinery Co. – is now mounting auxiliary engines of 180 to 190 hp capacity on the end of scrapers and loaders, and driving through a torque converter to the rear wheels. This is not an inexpensive approach, however.

What one observer considers the most significant development in construction equipment since the switch from gasoline to diesel engines recently was announced by Le Tourneau. Its official title is the Tournatow, but it has been called "the electrical wheel." (See illustrations.) Designed for shifting large bombers around airfields, it consists of a diesel driven electric generator with individual a-c motors driving each wheel through planetary gear trains. An auxiliary a-c generator supplies power for the steering motor. Motors are used for regenerative braking, but if power is accidentally shut off, solenoids set magnetic brakes to lock the armature. A similar system for application to a scraper was described in PRODUCT ENGINEERING, 1949.

Advantages of this type of drive:

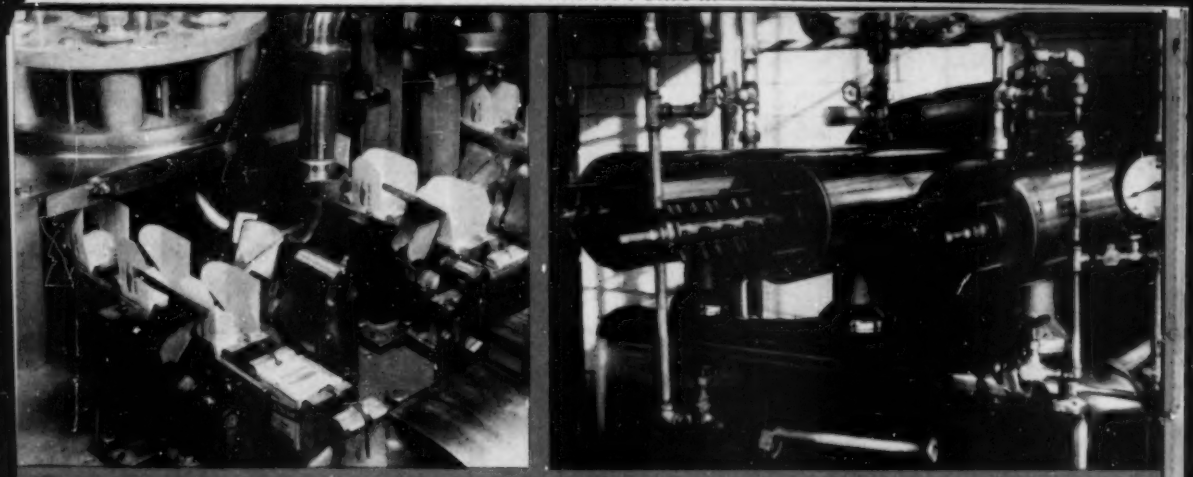
1. The elimination of all conventional transmissions, clutches, couplings, and drive shafts.

2. Simplified control, with infinitely adjustable speeds from zero to maximum, forward or reverse.

3. Power supplied to each wheel. Should it be desirable, booster power can be supplied to the wheels of trailer vehicles. It is not difficult to imagine complete rubber tired trains with power coming off a central generator of "the electric wheel"; such equipment already is visualized by the mining industry, as previously noted.

Another completely different type of equipment is a 600 cfm capacity portable rotary air compressor recently developed by Ingersoll-Rand. Its weight (about 9,000 lb) and size are essentially the same as a 315 cfm reciprocating unit, with the result that a truck can tow the machine whereas a tractor formerly was required to handle compressors of this capacity.

Ingersoll-Rand engineers reversed the established approach in designing this equipment. Instead of starving the compressor of lubrication to keep oil out of the air discharge lines and thus accepting rapid wear and decreased efficiency, they flood the



(Left) Packaging of ice cream in a high speed operation. This machine forms, fills, and closes 6,000 individual serving cartons of ice cream per hour at Arden Farms Co., Los Angeles. (Right) Equipment for continuously mixing, aerating, and emulsifying cake batter at a rate of 1,500 lb/hr at Farm Crest Bakeries, Detroit. (Photo courtesy National Biscuit Co.)

compressor with oil, which is subsequently removed through baffles and filters. Consequently, wear is no problem and the oil acts as a coolant to reduce the discharge air temperature to 200 F for the two-stage unit; normally 300 to 350 F is considered average.

Insofar as long-term trends are concerned, there are three besides the one previously mentioned. First, many small machines are being designed to take over jobs formerly done by manual labor. Portable cranes, front end loaders for trucks, machines for back filling of trenches, and an entire group of air-powered portable tools have been introduced.

Second, there is a trend toward special machines for one operation, as is the case in many industries; and lastly, there is a trend toward general purpose machines. This last trend is perhaps best exemplified by concrete mixers that carry a portable power hoist or movable booms to deliver the cement across excavations or to higher elevations.

In the FOOD FIELD . . . Continuous processing . . . High speed packaging . . . Sanitary design

With food equipment as with machine tools, the emphasis is on higher operating speeds and automatic controls. The food industry today is about at the stage that the chemical industry was fifteen years ago: it is just starting to convert from batch to continuous processes. To make the conversion successfully will require the complete redesign of old equipment, the development of new machinery, and the application of high-order process control devices.

Take the bakery industry, for instance. In an old style bakery, the flour and other ingredients came in bags, and cans. In a large bakery, these materials formerly were unloaded and stored, added to the rounders in required proportions, and taken from the mixers and put into pans which then were loaded in the oven. From that point, pans were taken from the ovens, stored in racks, and the bread later sliced and wrapped.

In the pushbutton bakery, the process is automatic. Dough is put into pans, which are transferred from conveyors to proofers, from proofers to ovens and from ovens to coolers and stackers – in effect, straight-line production. Formerly several men were required at each transfer point to do the work now done by a few limit switches, relays, and hydraulic pusher bars.

Accompanying the switch from batch to continuous processes is bulk transportation of foods. Rice, malt, sugar, and flour are being transported in bulk and handled from car to storage area by pneumatic conveyors. When a mix is required, as in a bakery, pushing a button sets it up automatically.

This automatic handling and process control results in several advantages, chief among which are: (1) higher production; (2) lower unit cost; and (3) better uniformity and quality of product.

Another development worthy of note is automatic high-speed packaging. Relatively new are two units that fill and vacuum cap glass containers from 3 to 8 in. in height and from 2 to 4½ in. in diameter. The units are connected by a conveyor and automatically sequenced. The 21 station filler supplies up to 575 jars per minute to the 16 spindle sealer that can vacuum cap at speeds up to 625 jars per minute.

Machines for automatic forming and filling of cartons, for filling and sealing polyethylene containers, and for check-weighing of cartons also have been developed and are being refined. None of these machines is of simple design. Rather, each is complex, and utilizes the latest developments in power transmission, electrical and electronic equipment and controls, and light weight mechanical components.

Materials also are being more carefully selected because of the trend toward sanitary design. (See PRODUCT ENGINEERING, Nov. 1950). Actually, there are three facets to this sanitary design, namely the use of non-corrosive metals, designing for quick knockdown and cleaning of equipment, and the elimination of rough joints and corners either by polishing after welding or by fairing out corners on castings. The materials being used are glass and inert plastics (for piping, lining of containers, and for some structural parts), stainless steel, and polished aluminum.

In TEXTILE MACHINERY... Mechanical handling... Universal machines... Higher operating speeds

Although the textile industry does not have the highest wage scales in the country, it has had the highest rate of rise of any industry in the past 20 years. In the 1930's, for example, the average wage was $.30 per hour; today, it approximates $1.20 per hr, even in the South. This rise, plus the impact of synthetic textile materials has caused a gradual evolution in textile machinery.

First of all, machines are more automatic and equipped to handle larger "packages"; where formerly, the machine output was limited by the man, today that limitation has been removed. Higher speeds, made practical by the application of design tools such as strain gages, high speed photography and instruments for vibration analyses are on the increase. The new Warner & Swasey loom, which has been in the experimental stage for several years, is now moving into the plant and its price – $7,910 as compared to about $1,000 for a Draper loom – can be justified only by much higher output per manhour.

Secondly, the increasing importance of such synthetic materials as Nylon, Orlon and rayon have forced a switch to universal machines. Formerly, mills installed one group of machines for cotton fiber, the average length of which is under 2 in. There was another group of machines for woolen and worsted goods. Today there are machines that will handle any length of fiber from one to nine inches in length, and thus are adaptable to any material including the new synthetics. McGlin-Hayes Industries, for example, manufactures a spinning machine which controls the fiber so closely that one inch fibers can be spun with reels 4 in. apart.

This change has necessitated use of variable speed drives on such machines to best adapt the speed of operation to the fabric being processed. Improved motors – lint free types with sealed pre-lubricated bearings – have decreased maintenance materially. Oil-less bearings make possible spindle speeds of 12,000 rpm or higher. Extensive use of light metals to reduce the inertia of moving parts also has contributed to increased speed of operation.

Greater use is being made by machinery makers and equipment suppliers of electronic equipment, as in the Crompton and Knowles electronic letoff, various moisture detecting control instruments and others.

Actually, with some few exceptions, however, the improvement in textile machinery represents a gradual evolution, as previously mentioned, rather than a rapid change. That this trend will continue is definite; and the trend toward mill modernization and toward faster methods of drying using both air and high frequency dielectric heating instead of steam will probably accelerate.

Dielectric heating has been under development now at duPont for several years for drying of rayon – five years at least. With it, as with induction heating in the case of metallic materials, heating is uniform throughout the cross-section of the object; with either steam or air, drying takes place from the outside in. Another important advantage of dielectric heating is that it is fast.

IN AVIATION... A prediction made five years ago looks good for the future

About five years ago, Frank Godsey, then Manager of the New Products Department of the Westinghouse Electric Corporation, presented a paper in which he predicted this trend in aviation: reciprocating engines for aircraft in short haul freight and passenger planes operating at speeds from 250 to 300 mph; turbo-prop power for commercial aircraft and long distance bombers operating in the 300 to 450 mph range; and jet propulsion for fighters and high speed bombers. That prediction is still good today.

However, there has been an increase in the size of gas turbine engines beyond that then visualized. Ratings of 5,000 lb thrust are common today, and 10,000 lb thrust power plants are – or will be – flying within the next few years. One pound of thrust equals one hp at 376 mph; at the speed of jet aircraft, some of which operate at 650 mph or higher, the hp output is doubled, since it is a straight line function of speed. Thus, the future four engine bomber may well have higher power capacity than a destroyer, eight diesel locomotives, or four hundred automobiles.

In this country, an experimental turbine propeller transport craft should be flying before the end of the year, with the expense being borne by the engine manufacturer and the airframe builder. Another transport plane manufacturer now says he will go into production on a pure jet airliner if he can get orders from the airlines for 25 to 30 – and there is reason to believe he is not waiting for such orders before building a prototype. Still another manufacturer is putting an all-cargo plane into production, although he has commercial orders for only a handful – an unthinkable project a year or so ago.

And all manufacturers are more daring in soliciting, and getting, airline contracts – one reason the backlog of transport business is higher than at any time since the war.

Another powerplant, just beginning to be researched in this country, is the ram jet. The beauty of the ram jet is that except for auxiliaries, it has no moving parts; capacity is a function of size; and projected speed of flight is on the order of 1,800 to 2,500 mph. Although in this country, the ram jet power plant is thought of primarily for pilotless aircraft, the French have several experimental models of piloted fighters that may be adopted as standard equipment.

Finally, the success of the Fairchild packet plane in military operations practically guarantees its adoption for air freight service when the present emergency is past. It may well prove to be the advanced prototype of similar specialized craft produced by other manufacturers.

The ram jet has been referred to as a flying stove pipe. Actually that is an apt description. Air enters the front of the engine and is compressed by the forward speed of the plane. Fuel is injected and ignited and the combustion gases shooting out the exit end provide the reaction that propels the plane forward.

As is apparent, these characteristics of operation immediately create several problems. First, the plane must have an appreciable forward speed before the ram jet can operate; otherwise the flame is lost through lack of air. Current thinking is to use auxiliary power plants to get the plane – or missile – off the ground, after which the ram jet can take over.

The other problem is fuel consumption, which is high, and necessitates carrying a large supply. However, unlike a rocket engine which operates once – or in bursts – the fuel supply can be controlled.

Of course, materials and constructions, as well as design of auxiliary equipment, is a problem for ram jets.

In ELECTRONICS and COMMUNICATION . . . Television . . . Radar . . . High speed computers

The biggest thing to hit the electronics industry in years is television. Were it not for the impact of the military program, television would push everything else to the background. Even so, the industry will keep going as long as possible with substitute materials. How long or to what extent the industry can absorb military contracts without severe cutbacks in civilian production is easy to answer: Not long.

In the peak year of 1944, the electronics industry produced about 4.6 billion dollars worth of goods. Last year, the dollar output with prices at factory levels was between 1½ and 2 billion. At the end of 1950, the government had committed itself by letters of intent or through contracts to the purchase of over one billion dollars worth of equipment. Now the military is talking of 5 billion in orders by the middle of 1951. In short, current military requirements are in excess of the peak dollar volume turned out by the industry in 1944. Even considering the shrinkage in the value of the dollar since the last war and the fact that the government is putting much money into radar or its equivalent – the unit cost per item being high – there has to be some give some place. The give will be in civilian goods.

Radar, loran, and equipment operating on a similar principle rate high in the military procurement program for two reasons: (1) it can be used to locate objects such as aircraft or submarines or to obtain "fixes" for navigational purposes; and (2) it can be used to aim a projectile or to control flight of an airborne object. It is into equipment of this type that many contractural dollars will be put.

The third major new use of electronics is in high speed digital computers, as well as in analog computers and punch card machines. Although in terms of market, these devices do not represent a large total dollar volume, they are extremely important and will prove even more so in the future – say 10 years. In complexity computers are far ahead of any other type of electronic device. It is not generally realized that Eniac, one of the first all-electronic high speed computers contained approximately 20,000 tubes. The new Bureau of Standard machines, SWAC and SEAC, have 500.

(1) *Printed circuitry* – has played an important role in expendable military equipment and will continue on a larger scale in the future. Some observers feel that long range civilian use is questionable because of the number of changes that usually are made in such equipment over a short period.

(2) *New materials* – Researchers are learning a great deal about certain dielectrics. There is a good possibility that some of these may be synthesized in the near future. Synthetic mica is already in production.

(3) *Germanium crystals* – are a two element device that can be used in place of a tube for such functions as half-wave rectification, detectors in radio and communications equipment, and for wave shaping functions in both civilian and military equipment.

(4) *Non-destructive testing* – using electronic equipment has really just begun to make significant progress. Look for more of this in the future. GE's new industrial X-ray equipment, for example, is said to make practical large-scale, low-cost high speed internal inspection of mass produced products.

In the STEEL INDUSTRY . . . Better materials handling . . . Electronic controls

The steel industry has been convinced that better materials handling equipment will materially reduce cost of operation. The job is not so much that of obtaining handling equipment of radical design as of modernizing existing plants and considering the problem in the design of new mills.

Electronic speed control is being used more and more extensively in rod mills because of its fast response. Motors are designed for high inertia loads to minimize the impact speed drop when the rods hit the rolls. This gives the regulator a chance to respond quickly enough to maintain speed.

Electronic edge controls are used extensively but thickness gage controls tied in automatically with the up-and-down screws are not widely applied because their excessive sensitivity would require almost continuous rotation of the screws and would soon wear them out.

X-ray thickness gages have been used for the past two years at the Sparrows Point plant of Bethlehem Steel Company. These gages measure the thickness all the way from the center of the strip up to the edge. With these gages, thickness is a function of the absorption of X-rays passing through the sheet or strip. There are no gage points to bounce, the measurements are taken all the way across the strip, the speed of the strip has no effect on accuracy, and the accuracy is high.

The trend in cold rolling is to high speed. This also is the case in tinning lines, and pickling and shearing lines. Up to 1938, 2,500 fpm was the maximum speed in tandem cold reduction. In the new U. S. Steel plant to be built near Trenton a speed of 7,000 fpm is contemplated. The highest speed at this time is 6,250 fpm maximum at a five stand cold reduction mill. All the drives are d-c motors which permit closer speed control.

IN AUTOMOBILES . . . Both large and small cars . . . Automatic transmissions . . . Nonferrous Materials

Car designers have concentrated on four features since the end of World War II: engines with higher compression ratios and much greater horsepower capacity; sleek streamlined bodies with a lower center of gravity; automatic transmissions; and all kinds of gadgets, from electrically or pneumatically operated windows to hydraulic steering.

Before the shift to military production, there seemed to be no limit on the horsepower ratings to which designers would go. The new Chrysler V-8 is rated at 180 hp and reports from Detroit are that it will develop 185 hp. LaSabre, GM's car of the future, is powered with a 300 hp 18 deg-eight engine of Buick design, and while that represents too large a jump, it is known that Buick has been working on an in-line V-eight for some time. In terms of rating it is interesting to compare the cars of 10 years ago with those of today (see table).

But no longer can designers rely on the petroleum industry for higher octane gasoline. Oil companies are at the point of diminishing returns; to

get another two or three point increase in rating requires too much investment in plant and equipment. It is cheaper to redesign the engine, using a bigger bore and shorter stroke and larger valves as the compression ratio is increased.

The increase in power of standard stock models plus the fair sales of small foreign cars has jolted many companies into taking another look at the small car field. Nash has had good reception with their Rambler series both in convertible and station wagon models. But the Nash, while having a small wheelbase, still is powered with an 85 hp engine and has the features of a luxury car—automatic top in the convertible model, air-conditioned heating, radio, and others. The new Henry J is lower in price and has fewer accessories.

Automatic transmissions have received considerable attention of late, the hydraulic torque converter, of the split-stage lock-up, or geared type, obtaining the major emphasis. Of the cars listed in the table, only two models are not available with an automatic transmission of some type. However, the torque converter may not prove to be the final answer. On less expensive models, an electrically or hydraulically actuated friction clutch which will give automatic control of acceleration but no torque multiplication may prove a feasible compromise.

The present shortage of materials will reduce the number of accessories and gadgets as well as chromium trim. Some of these practices may carry over after the present emergency is past, when designers probably will be forced into reducing (1) initial cost and (2) operating cost.

One way to cut operating cost would be to reduce the power loss between the engine and the road—about 25 to 30 percent of the developed horsepower being lost in transmission and to drive accessories. Whether part of this can be recovered remains to be seen.

Table I—Horsepower Ratings and Prices of Typical Stock Automobiles 1940-1951

TYPE AND MODEL OF CAR	1940			1951		
	ENGINE	HP	COST 4 DR.	ENGINE	HP	COST
Buick—Special	In-line eight	107 @ 3400 rpm	$ 945.00	In-line eight	115 @ 3600 rpm	$1,941.00
Buick—Super	In-line eight	107 @ 3400	1,045.00	In-line eight	124 @ 3600	2,139.00
Cadillac—60S	V-eight	135 @ 3400	1,995.00	V-eight*	160 @ 3600	2,866.00
Cadillac—72	V-eight	140 @ 3400	2,555.00	V-eight*	160 @ 3600	3,797.00
Chevrolet—Master Deluxe	In-line six	85 @ 3400	730.00	In-line six	90 @ 3300	1,450.00
Chevrolet—Special Deluxe	In-line six	85 @ 3400	765.00	In-line six	105 @ 3300	1,687.50
Chrysler—Windsor	In-line six	108 @ 3600	1,025.00	In-line six	116 @ 3600	2,348.50
Chrysler—New Yorker	In-line eight	135 @ 3400	1,260.00	V-eight*	180 @ 4000	2,783.00
DeSoto	In-line six	100 @ 3600	985.00	In-line six	112 @ 3600	2,008.75
Dodge	In-line six	87 @ 3600	905.00	In-line six	103 @ 3600	1,944.75
Hudson—Six	In-line six	102 @ 4000	839.00	In-line six*	145	2,501.50
Hudson—Eight	In-line eight	128 @ 4200	942.00	In-line eight	128 @ 4200	2,501.50
Lincoln	V-eight (Zephyr)	120 @ 3500	1,400.00	V-eight*	152 @ 3600	2,572.50
Mercury	V-eight	95 @ 3600	960.00	V-eight	110 @ 3600	2,031.00
Ford—Six	—	—	—		95 @ 3300	1,470.00
Ford—V-8	V-eight	85 @ 3800	725.00	V-eight	100 @ 3600	1,543.50
Nash—400	In-line six	99 @ 3400	853.00	In-line six	85 @ 3800	1,974.00
Nash—Ambassador	In-line six	105 @ 3400	961.20	In-line six	115 @ 3400	2,162.00
Oldsmobile—Six	In-line six	95 @ 3300	810.00	—	—	—
Oldsmobile—Eight	In-line eight	110 @ 3500	1,075.00	V-eight*	135 @ 3600	1,978.00
Packard—Six	In-line six	100 @ 3200	990.00	—	—	—
Packard—Eight (200)	In-line eight	120 @ 3600	1,240.00	In-line eight	135 @ 3600	2,355.00
Plymouth	In-line six	84 @ 3600	805.00	In-line six	97 @ 3600	1,566.00
Pontiac—Six	In-line six	87 @ 3600	890.00	In-line six	90 @ 3400	1,745.00
Pontiac—Eight	In-line eight	100 @ 3700	925.00	In-line eight	108 @ 3600	1,813.00
Studebaker—Champion	In-line six	78 @ 3600	745.00	In-line six	85 @ 4000	1,571.50
Studebaker—Commander	In-line six	90 @ 3400	965.00	V-eight*	120 @ 3600	1,838.75

1—All prices F.O.B. Detroit with standard equipment.
2—Current prices do not include automatic transmission except in case of Chevrolet special with Powerglide.
3—Prices on basis of most comparable models when model names have changed.
*—Represents major engine redesign.

More Production and Better Quality by Cold Extrusion

Refinement of the German process for extruding ferrous materials at room temperatures is rapidly reaching the point of widespread application. Materials and techniques for reducing friction between stock and die are getting the most attention. Both the government and industry are concentrating on the use of zinc phosphate crystals that are bonderized to the skin of a wide variety of steels.

Coincidental with these basic studies in technique are long-range programs for expanding press capacity. Small parts can be cold extruded in large mechanical presses of various types, but the emphasis is being placed almost entirely on hydraulic presses in which large-diameter billets can be worked.

Once techniques are perfected and large presses become available, designers will be able to take advantage of some or all of the following:

(1) Steel will go a lot further in the manufacture of both hollow and solid shapes. Scrap losses on a 35-lb projectile made by forging and machining often range from 6 to 20 lb. With cold extrusion, scrap loss is only about one percent.

(2) Not only low- and high-carbon steels, but also the alloy and stainless types containing chromium, nickel, manganese and molybdenum can be cold extruded.

(3) The physical properties of these steels can be increased appreciably, mainly through cold working. The Table shows typical values for ultimate and yield strengths, hardness, reduction in area and elongation. These figures make it quite evident that low-grade steel can do the job of the high-grade stocks.

(4) In many cases, finish machining will not be necessary, because the smooth surface of dies and punches is faithfully reproduced.

(5) Tolerances of a few thousandths can be held, and concentricity is high. Both of these factors will reflect economies because less machining cuts labor and materials costs. The concentricity factor is, of course, an important consideration with rotating parts.

(6) It is possible that many slight irregularities in the structure of raw stock are "ironed out".

An illustration of several of the above points is shown in the production of automotive transmission shafts at the rate of 1,600 per day. Medium-carbon 1½-in. bar stock is cut to 14-in. lengths, then heat treated to a tensile of 100,000 psi. After being cleaned and treated with lubricant, the bar is stretched in three press operations to a length of 22 in. Tolerances are held to ±0.001 in. and only a short machining operation is needed to bring the seven different diameters to size.

If this shaft were produced wholly by machining, a 22-in. bar 1⅝ in. in diameter would be required. Along the smallest diameter, 9/16 in. of metal would be machined away as scrap. Thus, by extrusion, three shafts can be made from the material needed for two machined shafts. And from the extruded shaft, only the material removed in final machining is lost.

Hot Extrusion of Steel

There are in this country three 5,500-ton presses that will handle billets up to 19 in. in dia and 47 in. long. Within a year or two at least one press rated greatly in excess of 15,000 tons will be a reality. It will then be possible to handle billets 27 in. diameter and 65 in. long. Fig.

Mechanical Properties of Cold Extruded, Heat-Treated Steels

PROPERTIES BEFORE COLD EXTRUSION						Degree Cold Reduction, percent	PROPERTIES AFTER COLD EXTRUSION				
Material	Average Hardness, Rb	Ult. Tensile Strength, psi	Yield Strength, (0.2% Offset), psi	Elong. in 2 in., percent	Reduction in Area, percent		Average Hardness, Rb	Ult. Tensile Strength, psi	Yield Strength, (0.2% Offset), psi	Elong. in 2 in., percent	Reduction in Area, percent
Ingot iron	29	42,500	17,900	45	72	20	73	70,500	64,300	17	55
						40	87	85,800	84,225	13	42
						60	93	98,375	94,625	13	48
						70	94	103,750	103,300	13	48
						75	95	106,400		10	43
						80	99	115,200		9	42
C1010	45	46,400	28,550	45	72	20	72	69,400	63,825	19	61
						40	91	94,150	92,050	16	55
						60	93	101,600	100,150	13	49
						70	95	108,500	107,050	12	47
						75	94	111,800		9	48
						80	100.5	116,950		9	39
C1020	57	58,000	40,250	38	62	20	79	79,800	77,325	13	48
						40	92	104,800	101,166	9	36
						60	95	115,250	114,450	9	35
						70	100	123,250	122,450	11	41
C1040	81	74,700	49,750	35	66	20	94	110,150	97,875	14	45
						40	99	125,750	112,550	12	41
A5120	74	76,750	47,750	32	44	20	90	91,900	80,150	18	67
						40	99	115,900	103,700	16	56
						60	102	129,450	120,125	16	53

Heintz Manufacturing Company

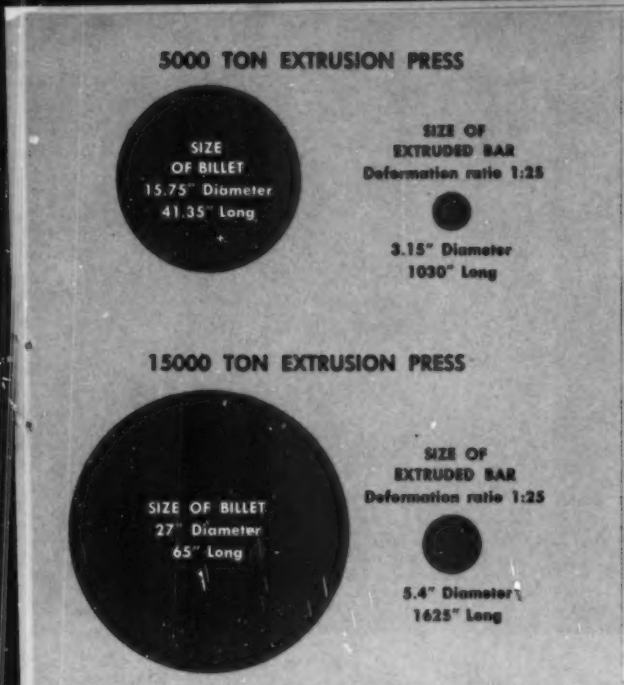


Fig. 1 — Comparison of billet and extruded bar sizes that can be handled hot by existing presses (5,000-ton) and by facilities that will become available in the next few years.

Hydropress, Incorporated

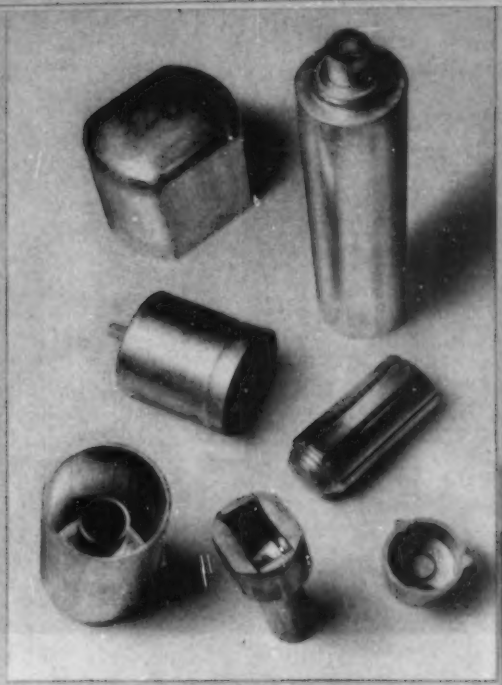


Fig. 2 — Impact extruded aluminum parts recently produced show trend toward complicated shapes. The rectangular cover and double-walled parts are particularly noteworthy.

1 compares the capacities of the two presses.

Considerable developmental work is being done in connection with a French technique, the Ugine-Sejournet process, for extruding hot, various grades of plain and alloy steel. Several companies have obtained licenses and will be turning out specialized shapes, both flat and circular, on a small scale by the end of this year.

The significant factors are the use of glass in place of graphite as a lubricant and the speed of extrusion — two to three seconds.

Extrusion of Aluminum

Recent developments in the field of extruded aluminum are notable both with respect to the production of extruded shapes by the hydraulic press process and to the production of parts by the impact extrusion process, especially the latter. The trend is toward larger close-tolerance parts having complicated shapes and improved surface finish.

Hydraulically extruded shapes of the finned and hollow type are becoming more numerous and this trend will continue. An example is integrally stiffened sheet used in aircraft structures. A 9-in. ID tube with external T-shaped fins having an OD of about 12 in. is extruded. The tube is then split lengthwise and flattened to produce a developed width of 28 inches. Considerable weight is thus saved and a large number of rivets eliminated. With the advent of larger, more powerful mechanical and especially hydraulic presses, larger sections will be possible. Die materials and lubricants appear to be somewhat less a problem than is the case with steel extrusion.

Impact-produced parts are probably in for more drastic changes, especially to high strength alloys. Though almost all of the aluminum alloys can be impact extruded cold, the majority are presently made of 2S and 61S alloys. Impacts made of the strongest, heat treatable alloys such as 75S are getting beyond the development stage and into pilot production.

The trends for impact extrusions can be summarized as follows:

(1) Through refinement in tool design, better tool materials, improvement of lubricants and techniques in metal preparations, better tolerances on OD wall and ID will be possible. The goal is the equivalent of close machining tolerances.

(2) Just as tolerances will be improved, the finish on impacts will be noticeably better. The objective is to obtain what is now considered a good ground finish.

(3) Multiple station impact extrusion will permit the production of parts of more complex design.

(4) Combination up-and-down impact extrusion will result in parts with large diameter upper sections and smaller diameter lower sections.

(5) Equipment of larger capacity will mean larger parts and particularly complex semi-solid parts.

(6) Some work is now being done on angular impact extrusion, that is, parts having extruded sections at approximately right angles from the vertical center section. Handles, wheel spiders and parts with side bosses are examples.

(7) General trend is toward more and more machine and assembly components made by the impact process, in addition to the increased use of the more common shell type parts. Many parts that are now drawn, die cast, forged or machined will come off the impact extrusion press in the near future.

Fig. 1 (Left) — Only half of this giant die forging press is shown. Overall height is that of six-story building, yet the individual parts are not too large for existing machine shop and rail facilities.
Hydropress, Incorporated

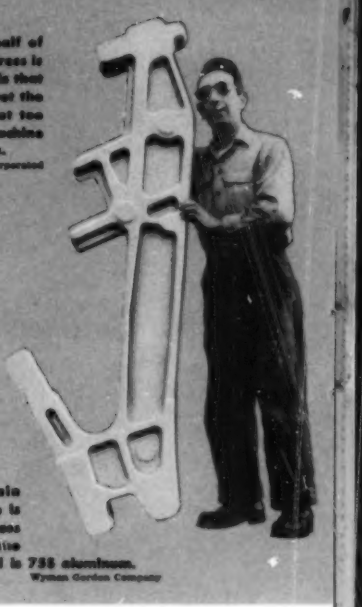


Fig. 3 (Right) — Main beam for fighter plane is forged on largest press now in operation in the United States. Material is 75S aluminum.
Wyman Gordon Company

Big Forgings Ahead

Since the discovery of a 30,000 metric-ton closed-die forging press in Germany after World War II, American forging experts have been conducting elaborate and accelerated development programs designed to improve the size, quality and economy of machine and structural forged parts. This trend will no doubt continue at an even more rapid pace. Much progress has already been made as is illustrated by the giant press shown in Fig. 1. This design is based on the size of existing machine shop and transportation facilities, and its rated capacity is expected to be on the order of 40 percent greater than the largest German press.

Drop hammers of conventional design rated at 45,000 lb have permitted the production of large steel parts for use in airframes, engines and propellers, but to meet the requirements of even larger parts, many press builders believe that the practical weight limit of the reciprocating parts (800,000 lb in some cases) has been reached. Undesirable effects are produced in the anvil and the base.

The solution to these problems was found through reconnaissance in Germany in the form of relatively small-size hammer forges of unconventional design. This type equipment is known as a counter-blow hammer and overcomes the undesirable features just mentioned, and provides the equivalent in forging performance of a conventional hammer of estimated rating of 100,000 lb. Fig. 2 shows the essential details of this type hammer in which parts weighing almost four tons can be forged.

In this hammer the large inertial mass required in the form of an anvil block is avoided by mounting the lower die in a movable ram that reciprocates counter to the upper ram and die. The two rams meet at the center of their combined travel with a complete conservation of momentum, in contrast to transmitting the force of the blow through the forging to the "stationary" anvil block and foundation.

As the trend continues toward the use of larger and higher-quality forged parts, both ferrous and nonferrous (Figs. 3 and 4), the developments in the next five years will probably be along the following lines:

(1) Better heating preceding forging will be needed if high quality forgings are to be consistently produced. Close control of time-temperature cycles insures proper structure and better surface quality. Oxidation within the furnace will also be a problem, especially with forgings having large sections. High-frequency induction heating, controlled atmospheres or molten salt baths will play more important roles.

(2) Improved post-forging cooling techniques will be needed if large parts are to be produced without internal stresses or cracks.

(3) Bigger and better die blocks will be needed to handle larger parts. Huge hydraulic presses will be used more and more to obtain reduced-speed die travel in forging the light metals.

(4) As is the problem with most metal forming techniques, better die lubricants will be needed.

(5) Considerable thought will be given to the processes of decarburization and carbon restoration, both of which are problems in the forging of steel.

(6) Large-sectioned parts made from aluminum-, magnesium-, nickel-, copper- and titanium-base alloys will present problems concerned with structural soundness. Research programs similar to those conducted by steel producers will be set up by the nonferrous groups.

Cored Forgings

A technique by which relatively small brass parts can be forged with cored holes in as many as four positions in one plane has recently been put on a production basis. To date, the process has been used primarily for making various plumbing fittings

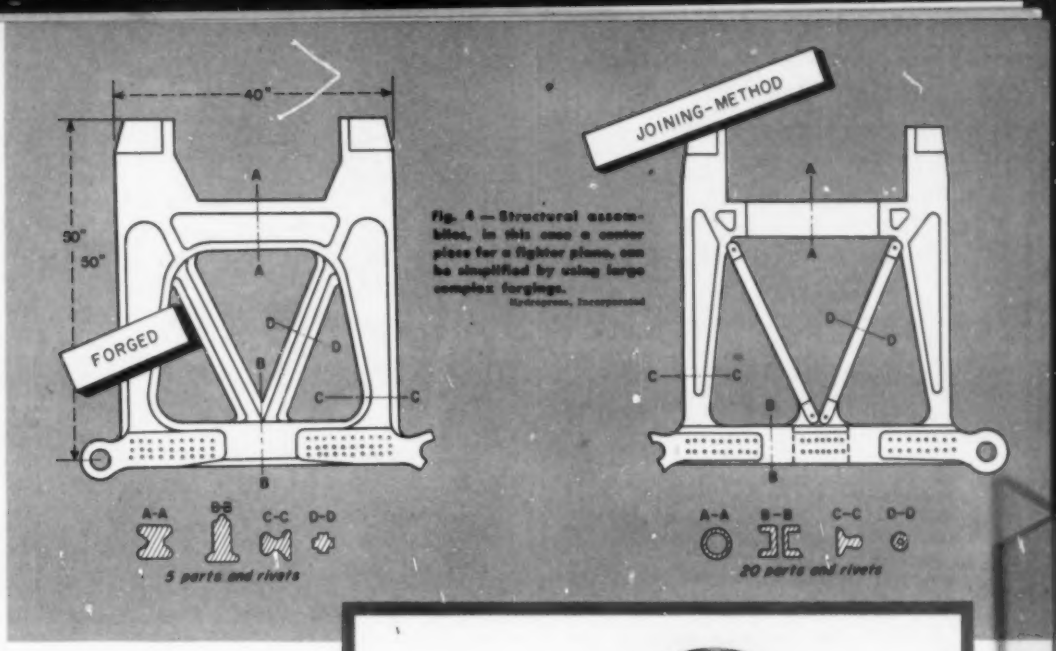


Fig. 4 — Structural assemblies, in this case a center piece for a fighter plane, can be simplified by using large complex forgings.
Hydropress, Incorporated

– elbows, tees, crosses and some valve parts – in either split or closed dies.

The principal advantages of the process as applied to brass are the multiple coring without draft, close tolerances of ±0.005 in. and smooth internal and external surfaces. Holes up to 2 in. in diameter and 2 to 6 in. (depending on position of core) depth are producible in production runs having a very short cycle time.

Materials savings ranging from 10 to 25 percent can be realized, mainly because the cores are deeper than those obtained by conventional methods. There is only a small amount of material that must be drilled or punched out when the web at the bottom of a cored hole is removed.

Within the last few months, this technique has been adapted to forging commercially pure titanium. Though titanium is more difficult to work than brass, there is hardly any difference in shape and finish in two parts, one of titanium and the other brass, formed in the same die.

The mere existence of this titanium forging indicates that one more hurdle has been cleared. In the light of this accomplishment, many parts that must be corrosion resistant and/or light in weight will be produced in the years immediately ahead. Chemical processing equipment, hydraulic systems and aircraft structures are just a few of the likely applications.

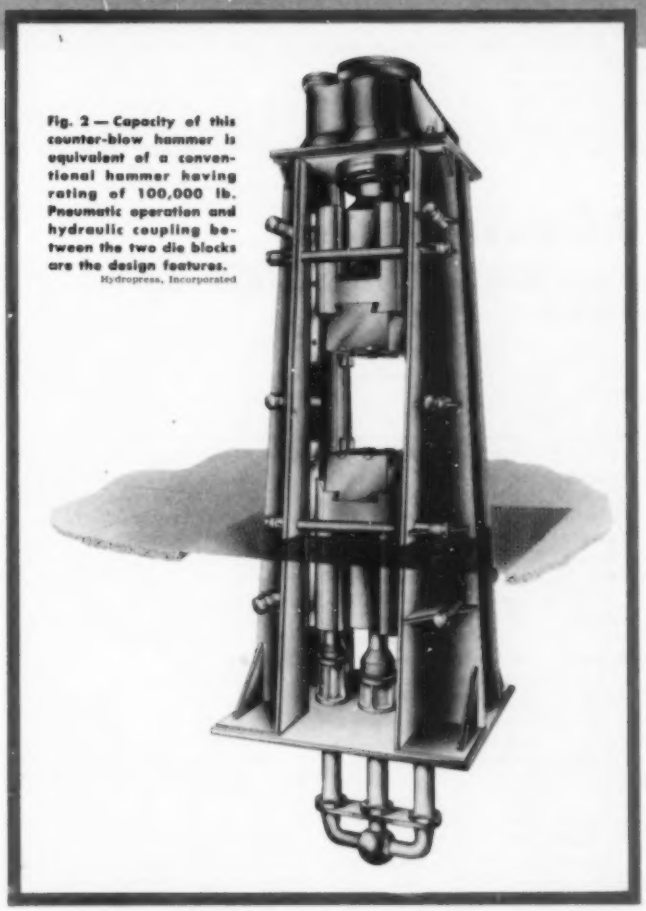


Fig. 2 — Capacity of this counter-blow hammer is equivalent of a conventional hammer having rating of 100,000 lb. Pneumatic operation and hydraulic coupling between the two die blocks are the design features.
Hydropress, Incorporated

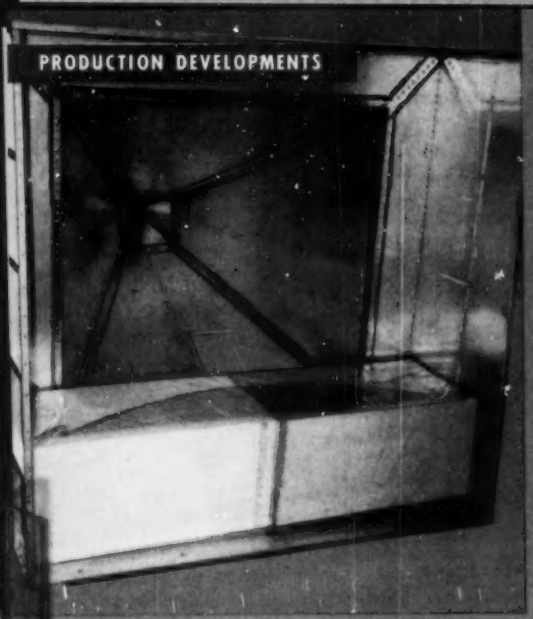


Fig. 1 — Acrylic resins are used to bond 144 styrene foam combinations and sections of a metal lens into each of the eight blocks that make up this relay lens antenna. Ten-foot square assembly is part of a cross-country radio relay system. Bell Telephone Laboratories

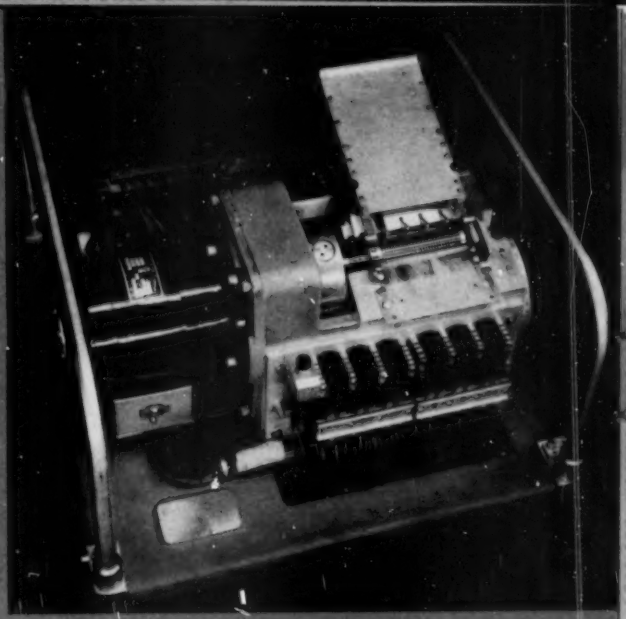


Fig. 2 — Contact assemblies used in telephone answering equipment owe their compactness and ease of assembly to the use of dry-film adhesives. In each stack of contact springs there are four adhesive bonds. Mechanical staking, riveting and fastening were formerly used. Bell Telephone Laboratories

Adhesives fasten . . .

Aircraft Members . . . Telephone Parts . . . Relay Stacks . . . Brake Shoes

High strength adhesives have been developed for bonding just about any material except those with waxlike surfaces, such as polyethylene, Teflon and Kel-F. Thin sheets of these latter compounds can be bonded with permanently tacky adhesives like the polyisobutylenes. However, such bonds are not for structural uses.

Among the most recent developments are the epoxy or ethozylene resins. These resins are 100 percent solids that shrink only slightly on curing. They can be cured at room temperature or at elevated temperatures if a faster cure is needed. The properties of minimum shrinkage, low temperature cure, good adhesion anl low pressures needed for cure make these resins ideal for some purposes. They bond to a wide variety of both porous and non-porous materials and need very little pressure and heating equipment.

Another class of 100 percent solids adhesives is the furane resins. These are especially noted for their adhesion to thermosetting plastic materials and can be cured either at room or elevated temperatures. Resorcinol nylon is an example of the room-temperature-curing type. The importance of this type is that it reduces strains caused by shrinkage and temperature differentials. Such an adhesive also produces a relatively non-porous bond.

The number of resins used in high strength glass cloth laminates is constantly increasing These include the above-mentioned epoxy resins, also allyl glycol esters, unsaturated polyesters, silicones and nylon. Each of these resins imparts different properties to the laminates and their choice depends on whether the user is interested in heat resistance, electrical strength or other properties. Laminates with the epoxy resins have given strength values as high as 85,000 psi in flexure.

Rivets are being replaced more and more by phenolic elastomer adhesives in bonding linings into brake-shoes. These same adhesives are also used extensively in airplane construction. One-third of the surface of the B-36 is reinforced with members held by adhesives. Some of the advantages of this type of construction are that smoother, strain-free joints exhibiting high strength and good corrosion resistance can be obtained.

Adhesives are continually being improved with regard to retaining their strength and flexibility at extremes of cold and heat, Fig. 1. A phenolic acrylonitrile resin combination has been found to retain a greater degree of strength at high temperatures than most other adhesives. Military needs specify that adhesives should remain flexible and stable at all temperatures between −70 C and +250 C. Chances are that several types of resin will be needed to bracket this temperature range and that the universal adhesive will be a long time in coming.

More widespread use is being made of general purpose rubber-based adhesives that bond a wide variety of materials. These adhesives are convenient to use and do not need much in the way of application equipment. Some are air drying at room temperature, others also vulcanize at room temperature to produce a more permanent bond.

Silicone adhesives for bonding sil-

icone and other types of rubber to non-porous materials are also under development. Chemically, they are the most heat resistant adhesives, but they are low-modulus resins that cannot be used where high strength bonds are required.

Dry Film Adhesives

Through the use of a 0.002-in. dry film of adhesive, the thickness of which can be accurately controlled, uniform thickness of a bonded area can be assured. No time is required for solvent evaporation and sheets can be cut to desired shapes, thus facilitating automatic machine assembly of different metallic and non-metallic combinations into laminated structures.

The adhesive film is applied by sandwiching it between two surfaces to be bonded and clamping the assembly to produce pressures that range from 20 to 1,000 psi. The assembly is then heated to a temperature of 300 to 450 F. The time allowed for cure is a function of temperature and may range from 30 min to 15 sec. The resultant bonds have tensile strengths of 5,000 psi and accelerated aging tests indicate that they last for more than 20 years.

These dry adhesives are becoming more widely used in metal assemblies, and for bonding dissimilar materials in electrical and electronic applications. Two steel plates formerly ground and then drilled and tapped for 13 machine screws are now pressed together with the film between and then induction heated to a complete cure in two minutes. The new Bell Telephone headpieces contain fiber diaphragms that are attached to circular metal rings with a phenolic resin dry film. Relay stacks are now assembled with this type adhesive instead of being mechanically fastened with screws or rivets (Fig. 2). Another use is for bonding copper foil to the phenolic laminate base in printed circuit assemblies.

These applications are indicative of a trend toward adhesive bonding in cases where large-scale production of mechanical and electrical assemblies require quickly-obtained, high-strength joints. As the number of pieces to be bonded increases, the costs of specialized assembly, heating and clamping equipment become more readily justified.

When it is considered that many of these laminated assemblies, whether they are similar or differ in shape only slightly, could be pressed and heated simultaneously, some cost factors become less important.

Powdered Metals . . .

May answer high temperature problem

With the perfection of a technique for infiltrating iron powder with copper alloy, it is now possible to mass-produce jet engine blades having a yield strength of 90,000 psi. These pressings are able to withstand three to four times as much vibration as 403 stainless and eight times as much as carbon steel blades.

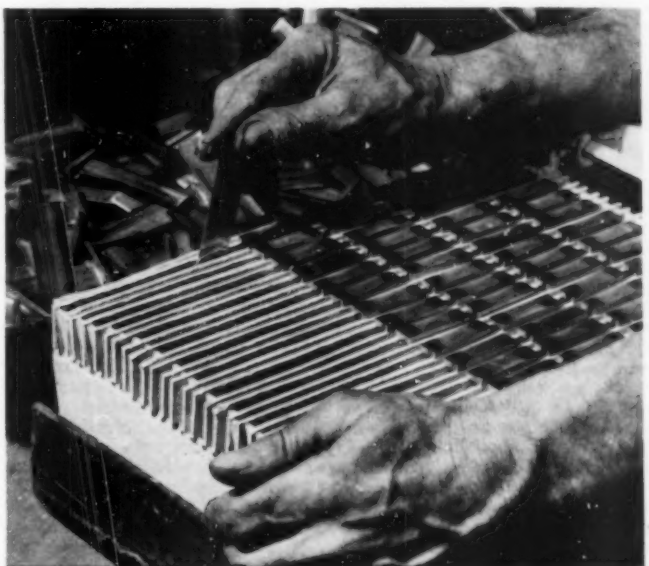
The current restrictions on metal and increasing demands on machining facilities are more than likely going to bring powder metallurgy more into the limelight. Precision parts weighing five pounds and measuring 18 in. in diameter can now be made. Thus, the advantages of little or no machining, minimum scrap, and comparatively low cost production equipment may well be capitalized through the redesign of certain parts now being forged or machined.

Iron powder similar to Swedish sponge iron is now in pilot production. This material, which approaches the purity of electrolytic iron powders, eases compacting because of its structure. Iron cores used in electrical and electronic applications exhibit lower hysteresis and eddy current losses than do similar parts made of existing powders.

Rolled strips of iron, steel, bronze and Permalloy have been successfully produced; also composite multi-layer materials such as soft iron on two-percent-carbon formulations. Five passes in a rolling mill result in as-sintered RZ iron powder sheet having tensile strengths of from 43,-500 to 45,000 psi. This process appears to be particularly suitable for the production of various types of soft magnetic materials.

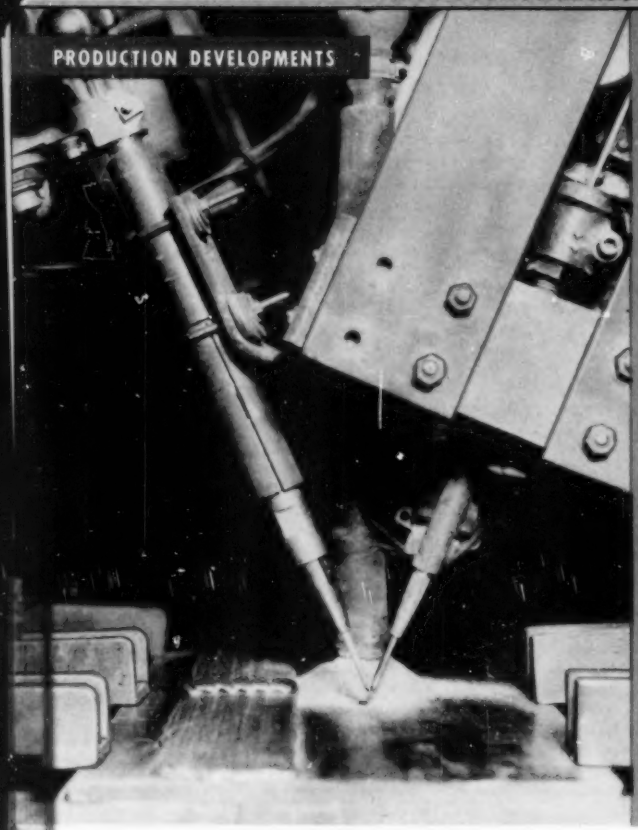
In the event of a pronounced swing to powder metallurgy as the result of materials and production equipment shortages, it is possible that this process will be the answer for materials having satisfactory strength and corrosion resistance at extremely high temperatures.

Typical of this line of thinking is the use of high-density powder metal pressings in the form of valves for various types of automotive engines. Other critical parts are no doubt in the early stages of development.



Copper alloy infiltration of porous-iron jet-engine blades in a 1,000-F hydrogen furnace brings density up to 90 percent of perfect uniformity.

Thompson Products Incorporated



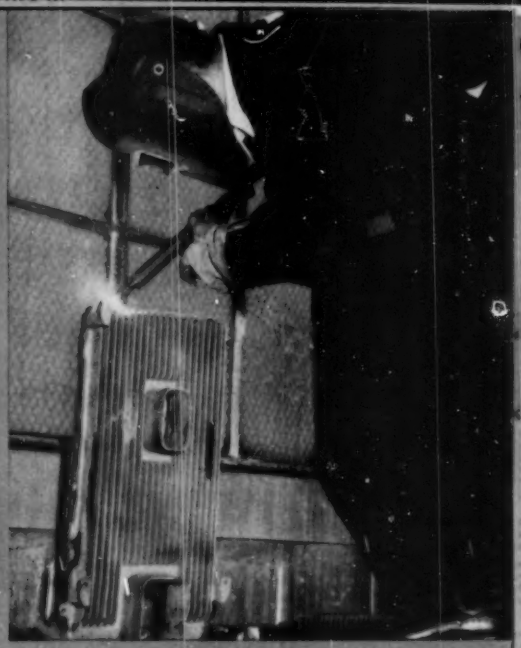


Fig. 1 (Above) — Heliarc-shielded arc welding permits assembly of this cast-aluminum space heater at rate of 12 per hour.
Air Reduction Sales Company

Fig. 2 (Left) — Series-arc welding stainless steel overlay on weld steel base. Current passes from one electrode to other, not through base material, resulting in a shallow weld.
Linde Air Products Company

New Welding Methods for Tough Jobs

Inert-Gas-Shielded Metal Arc Welding. This recently-developed welding process utilizes a continuously fed bare-wire electrode. The technique combines the key advantages of other welding processes with new features of its own. In manual operation, it has the flexibility of stick-electrode welding but there are no electrode changes. It is flux-free and fully shielded; has the high speed and economy of automatic welding methods, but with the added advantages of position welding and a visible arc.

The key to the usefulness of the process is its value for rapid large-volume production. It is primarily suited to jobs where a great many parts or a large amount of weld metal is an important production factor. Generally speaking, weld quality is excellent and, on some materials, appreciably better than could reasonably be expected from previous experience.

Both helium and argon are effective as shields. Helium creates a hotter, deeper-digging arc, with somewhat more spatter; argon yields a softer, smoother arc, shallower in penetration. Where characteristics other than those procured by helium or argon alone are desired, a mixture of suitable proportion is the answer.

Of the many aluminum alloys, 2S and 3S welded, with 2S filled wire, develop almost the full strength of the annealed base metal. Application to cast aluminum is shown in Fig 1. Welds in 61S plate with 43S wire develop the greater proportion of the annealed-metal mechanical properties, and are susceptible to heat treatment for greater strength. Certain casting alloys of aluminum are also weldable on a production basis.

One of the likely prospects for the shielded-arc process results from its effectiveness in depositing aluminum bronze. The new technique makes joining or overlaying with this material not only economically efficient, but also a high-quality operation. Special equipment, particularly for low-temperature service, can make good use of the special properties of aluminum bronze weldments. As an overlay, aluminum bronze is already proving useful for a semi-hard, durable and corrosion-resistant surface in valve seats and gaskets in pump and compressor heads. This material is also valuable as a means for joining dissimilar metals. Silicon bronze can also be satisfactorily welded. It has a wide field of use in special chemical equipment and related applications.

The austenitic chrome-nickel stainless steel can be successfully welded in all positions, without any special considerations other than those always applied in welding these alloys. A wide range of currents and speeds is available, permitting excellent control of penetration and bead contour.

One of the peculiar features of shielded-arc welding is its ability to effect an almost loss-free transfer of alloying elements through the arc. Even the titanium in stabilized stain-

less steel, which is lost in conventional arc welding, transfers with fair efficiency, and in most cases, there is no measurable loss of alloys. This is a key factor in applying the process to the special heat-resistant jet-engine alloys, and the other highly special metals of the future. A few such materials (S-590 jet engine alloy, for one) have been commercially proven by trial, but much of the possibility in these materials is a matter of future development.

Coated Electrodes for Metal-Arc Welding. The last few years have seen the development and application of the low-hydrogen ferritic type of electrodes which are superior in some respects to conventional electrodes in that they produce higher quality weld metals. Weld joints made with them are not subject to cold cracking. These electrodes are used for making high-strength joints in alloy steels, ranging up to 120,000 psi ultimate strength in the as-welded condition. Up to 200,000 psi ultimate tensile strength has been obtained in fully-treated joints made in alloy steels. Ferritic electrodes are rapidly replacing less effective and strategic austenitic electrodes for welding ferritic armor. Further developments and applications can be expected for use in welding alloy and structural grades of steels.

Guide to Choice of Welding Process

PROCESS	Steel	Cast Steel	Cast Iron	Aluminum	Magnesium	Copper	Bronze	Brass	Lead	Stainless Steel	Nickel
GAS	A	A	A	B	B	D	C	A	A	B	B
THERMIT	F	F	F	–	–	–	–	–	–	–	–
METALLIC ARC	A	A	B	D	E	D	A	B	E	A	A
CARBON ARC	D	E	E	D	E	F	C	C	E	E	D
SUBMERGED ARC	F	D	E	E	E	D	E	E	E	A	A
INERT GAS ARC	F	F	F	A	A	A	B	B	A	A	A
ATOMIC HYDROGEN	D	E	E	B	E	E	E	E	E	A	A
RESISTANCE	F	D	E	B	B	D	D	D	E	B	A
BRAZING	F	A	F	B	D	A	A	A	E	C	A
INDUCTION	F	E	E	F	E	E	E	E	E	B	A
PRESSURE (cold)	E	E	E	A	E	A	B	B	A	E	B

A—Highly recommended
B—Recommended with special operating techniques
C—Recommended, but some compositions present problems
D—Can be used, but generally other processes more suitable
E—Not recommended
F—Excellent for specific applications

Linde Air Products Company and American Welding Society

Submerged Melt Welding. This process, until recently, has been used chiefly for automatic welding of parts positioned so that welding is done in the flat position. It is now possible to make fully automatic welds in the horizontal position, and many miles of large-diameter pipe have already been made in this manner. It is expected that vertical welding will soon be common practice, thus opening up a much wider field of welding to this process. Also, manual welding will be done more rapidly in the future by horizontal and vertical submerged melt welding. Series-arc welding, as illustrated in Fig. 2, will also play an increasingly important role in applications where alloy dilution and shallow welds are important factors.

Gas-Shielded Tungsten-Arc Welding. This versatile method of welding aluminum, stainless steel, magnesium alloys, and many other metals and alloys has recently been made more useful by two new developments. Special tungsten electrodes have been developed containing thoria, which makes it possible to use higher welding currents on a given diameter of tungsten than have formerly been used. This makes possible higher welding speed and longer tungsten life. These thoriated-tungstens also do not become contaminated by other metals as did the previous standard-type tungstens.

D-c has recently been used for welding aluminum by this process, which previously used only alternating current. High welding speeds and deeper penetration have been obtained with direct current, which extends the range of usefulness of this process to more high-speed automatic applications.

Resistance Spot Welding. Power demands of this type of welding have often been a serious problem, since power from only one phase of a three-phase power line could be used. Recently, three-phase machines have been developed to a high degree of perfection, thus making spot welding more feasible for many applications.

Steel plates up to ¾-in. thick and aluminum alloys up to ½-in. thick are now joined experimentally by spot welding. This method of fabrication is expected to receive wide application for subassemblies of ships and various types of transportation equipment. Spot welding of aluminum alloy is also being accepted and used in some of the primary structural parts of aircraft.

Cold Welding. This process of welding is not necessarily new. However, it has recently become attractive for joining aluminum, copper alloys and other metals. By this process, metals are joined at room temperature by forcing two cleaned pieces together under pressure. It is usually necessary for the two pieces to flow or move over each other to a certain extent before a bond results. This process shows promise for a few applications at present, and may become more important in the future. Its potential usefulness may be in joining metals and alloys that are damaged by the heat used in all conventional welding processes.

To date, cold welding has been applied on a limited scale to seam-welded light gage aluminum tubing. And aluminum rod has already been successfully butt welded at room temperatures. Other possibilities include attachment of the buttons in ignition contact assemblies and at connections in electrical circuits using aluminum conductors.

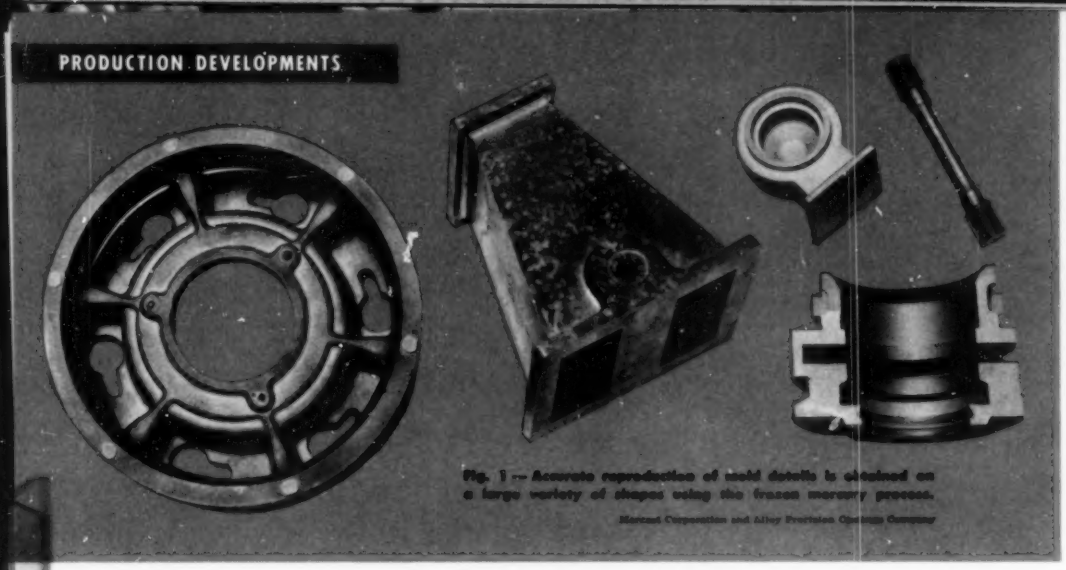


Fig. 1 — Accurate reproduction of mold details is obtained on a large variety of shapes using the frozen mercury process.

Harvest Corporation and Alloy Precision Castings Company

Investment Castings Coming Up

The investment casting process is particularly suited to the production of intricate parts and parts to be made from alloys which are difficult to machine or which cannot be machined. Properly made castings generally have smooth surfaces and can be held to tolerances of from 0.002 to 0.008 in. per in. Design of the molds and conditions of casting can usually be varied to suit the particular metal being cast, so that the mechanical properties may be equal to and sometimes superior to those of wrought materials. Most types of alloys, including iron-, nickel-, cobalt-, zinc-, copper-, aluminum-, and magnesium-base alloys, can be cast in investment molds.

While most castings of this type weigh less than two pounds, with the help of specialized techniques, more and more parts that weigh as much as 10 and 20 lb. will be appearing. Castings weighing up to 60 lb. have been produced, and it is not unreasonable to believe that more of the relatively large sizes will be made, especially if one or more phases of the investment process are simplified and mechanized.

Castings made from alloys melting below 2,000 F are usually cast in molds consisting of silica bonded with plaster. Higher melting alloys, such as iron-, nickel-, and cobalt-base alloys, require more refractory investments. These usually consist of silica or refractory silicates bonded with colloidal silica or the reaction products of magnesia and an acid phosphate. They are somewhat more expensive and more difficult to use than the plaster-bonded investment. For these reasons, it is preferable to use the plaster-bonded investment except for those metals that require highly refractory molds.

Since the investment method of molding proved to be an economical process for making certain types of castings, many variations in technique have been developed. Although these variations continue to utilize the fundamental principle of investment casting, they make the method versatile enough to meet a wide variety of casting problems.

Early use of the process for making industrial castings utilized wax replicas almost exclusively. Injection molded plastics, particularly polystyrene, are now widely used instead of wax. The higher temperatures and pressures necessary in molding plastics require the use of machined steel dies and rather costly injection presses for making the replicas.

Waxes, on the other hand, can be injection molded with low-pressure hand-operated presses. Under these conditions, low-melting alloy replica dies can be used. Cost of these dies, which can be made by casting or hobbing, is much less than for machined steel dies. But steel dies have the advantage of lasting almost indefinitely if properly handled, whereas, low-melting alloy dies distort or change dimensions after continued use. For this reason, machined steel dies are now used almost exclusively for large runs of a single part even where wax is used as the replica material. For use in making replicas, plastics are rapidly gaining in favor over wax where the volume of parts made and the precision required justify the cost of steel dies, and where high-pressure injection equipment is available.

Waxes are brittle and easily chipped or broken, or if they are compounded so that they are not brittle, they are soft and distort readily. By comparison, plastics are tough and much less subject to breakage and distortion. They have the further advantage of lower coefficients of thermal expansion, so that variations of temperature at the time of investing are less serious. In addition, polystyrene is appreciably less costly than suitable waxes.

Frozen Mercury Process

A relatively new variation of the investment casting method, which employs frozen mercury replicas and somewhat different investing techniques, has further increased the utility of the investment method. Frozen mercury accurately reproduces the details of the mold as shown in Fig. 1. Replicas are less subject to distortion and their dimensions are affected less by slight temperature variations than are the dimensions of wax and plastic replicas. Castings having a surface finish of 50 to 70 micro in. rms are obtainable

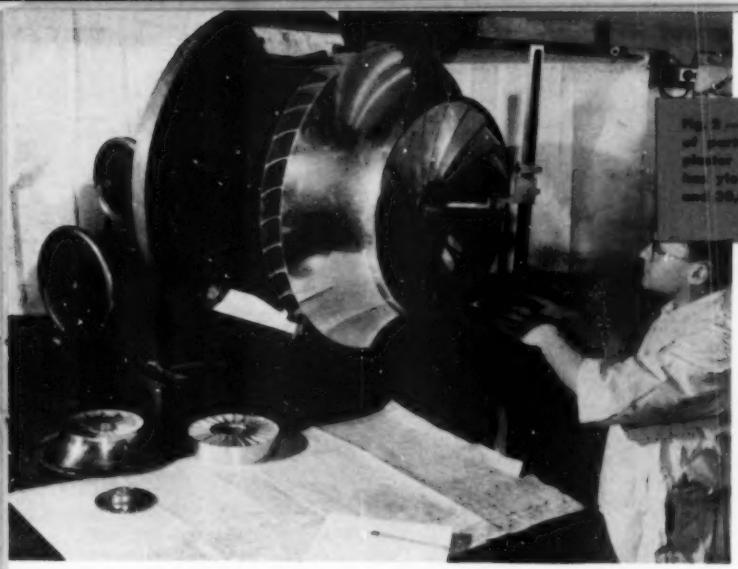


Fig. 2 — Compressor impellers illustrate the type of parts producible by the permanent mold plaster casting process. The 12-in. unit at left has yield strengths of 27,000 psi at the hub and 36,000 psi in the shroud.

Arizona-Pioneer Division, Bendix Aviation Corporation

(as cast) if polished molds are used to make the replicas and the refractory which forms the mold surface is sufficiently fine. In using frozen mercury replicas, temperatures of from −85 to −155 F are used. These temperatures are obtained with dry ice or mechanical refrigeration.

The investment is maintained in the form of thin slurries and it too must be kept below −40 F. It is applied to the replicas by sequential dipping in the slurries with a subsequent drying period. The investment is built up in this manner to form a shell mold ⅛ to ¼ in. thick. The coated replicas are then held at room temperature until the mercury melts and runs out, leaving the refractory shell. The shells are given the necessary support and fired to 1,850 F and then cooled to the desired casting temperature.

Frozen mercury has the peculiar property of welding when separate pieces are brought into contact. This makes it easy to assemble replicas in clusters for investing and to produce highly complex replicas that cannot be made by any other method.

Because the investment mold consists of a thin shell of strong refractory, it is possible to vary, within limits, the manner in which the casting is cooled. The supporting material may consist of unbonded sand or materials having greater or lower thermal conductivity than sand. The casting and shell may also be quenched in water, oil or air blast. These variations permitted in cooling rate make it possible to exercise some control over the properties of the alloys cast.

Regardless of the method by which the investment molds are made, melting of the alloys can be carried out in any manner normally used for the metal being cast. The molds can be cast statically, with the aid of suction applied to the bottom of the mold; pressure cast; or centrifugally cast. Because centrifugal casting yields a high ratio of finished castings to metal poured and particularly sound castings, this method is used extensively.

Ten-pound castings are routine, and present users of the mercury process are capable of handling with existing equipment parts weighing 20 lb. The ultimate limit of size is not yet known. Tolerances of 0.002 to 0.005 in. per in. can be held, depending on shape and metallurgical factors.

The nature of the frozen mercury pattern and the associated highly refractory thermal shock-resistant shell investment makes possible the casting of parts with extended sections of 0.020-in. wall thickness. Hollow jet engine blades now being mass produced have such wall thicknesses.

Plaster Casting

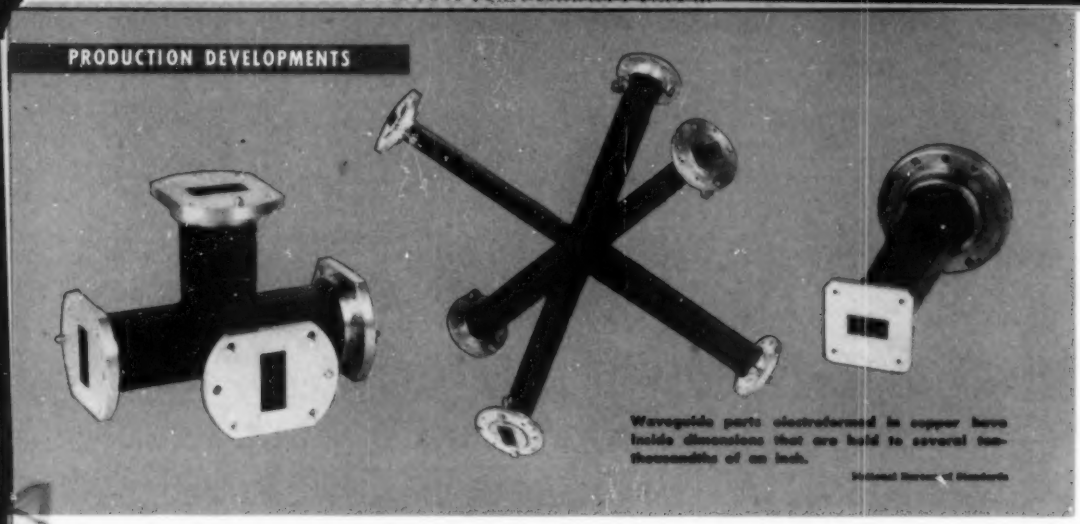
This term refers to a molding process which utilizes the cope and drag method similar to that of sand molding, except that plaster of Paris or specially compounded plaster mixtures are substituted for the sand. The plaster is vibrated or forced by pressure over metal or rubber patterns to form the two sections of the mold. After the plaster has hardened, the patterns are withdrawn and the molds are baked at 600 to 700 F to remove moisture. This method of casting is limited to use with metals that have melting points below 2,000 F such as brass, bronze, aluminum and magnesium. Sufficient draft must be allowed on the patterns to permit withdrawal from the mold, particularly in cases where metal patterns are utilized.

Many of the aluminum and magnesium castings that can be made by this process are readily produced by the more economical pressure die casting method. For this reason, cope and drag plaster molding of the light metals is limited in its utility to relatively short runs of castings which cannot normally be produced economically by pressure die casting. In pressure casting brass and bronze parts, however, the present die materials deteriorate rapidly, and plaster casting may, therefore, become the more economical method in the years ahead.

Casting surfaces and dimensional tolerances obtained by plaster casting are nearly equal to those obtained by pressure die casting. Because of the insulating effect of the plaster, the metals generally have coarser grains and slightly lower tensile properties than are obtained with metal molds or sand castings.

By utilizing cores in conjunction with plaster molding, it is possible to produce exceedingly complicated shapes. Sections of the molds are produced from plaster in metal core boxes in about the same manner that sand cores are made. The separate sections are then assembled to form a mold. Where cores are used, it is possible to produce cast shapes that could not be made by pressure die casting.

For casting the lower melting metals, plaster cores as well as sand cores can be used in conjunction with permanent metal molds (Fig. 2). Metal cores are usually used except for making intricate shapes where they might cause cracking or be difficult or impossible to remove. Where this is true, plaster cores may be satisfactory and result in improved surfaces and dimensional tolerances in comparison to those obtained with sand cores now widely used.



Waveguide parts electroformed in copper have inside dimensions that are held to several ten-thousandths of an inch.

Next Electroplating Techniques

1. Alloy Deposition
2. Use of Rare Metals

Of the 30 metals that can be deposited from aqueous solution, the deposition of only about a dozen has become of commercial importance. Among these are nickel, copper, tin, lead, zinc, cadmium, chromium, gold, silver and rhodium. Many of the other electrodeposits have not yet found any utilization, but with the great growth of technical industries, particularly those concerned with electronics, special types of coatings may play a small but important part. Accompanying table shows metals that can be deposited. Some of the less common metals have useful properties and are now being deposited to a small extent. For example, indium is used in bearings, and palladium for corrosion resistance. Manganese protects steel sacrificially, in the same manner as zinc, and is very hard, but no use has yet been made of electrodeposited coatings. Antimony deposits are bright and corrosion resistant to acids. Tellurium may be useful because of its high electrical resistivity. Gallium is liquid at room temperatures. These less common metals will gradually find special uses, but one cannot predict when or where.

Metals can be co-deposited from aqueous solution to form true alloys, a large number of which have been studied. Up to the present time only a few alloys – brass, nickel-cobalt alloy, and lead-tin – have found any commercial utilization. The first two are used for decorative purposes.

A present-day trend is the development of alloy plating to the point where the processes are commercially feasible, but the adoption of the processes is slow because of the increased difficulty involved in the control of alloy plating solutions. Electrodeposited alloys have certain advantages over the pure electrodeposited metals, as they may be harder, finer-grained, brighter and more corrosion resistant. Certain of them undergo a precipitation type of hardening upon heat treatment. In addition, alloys can be obtained of tungsten and molybdenum, although these metals cannot be deposited in the pure state from aqueous solution. Bronze plating and speculum plating have been developed by the English and are commercially feasible. The latter alloy is hard, has a pleasing white color and on tableware resists tarnish better than silver.

A copper-tin-zinc alloy is readily obtained with a bright decorative appearance. Zinc-tin alloys have very good corrosion resistance. Copper-lead and silver-lead alloys are useful for bearings. Cobalt-tungsten alloys have unusually good hot-hardness. The electrodeposition of phosphorous alloys containing nickel or cobalt has been developed at the Bureau of Standards. Also a process has been developed for depositing them without use of an electric current. The process permits deep recesses, which are not easily accessible to current flow, to be nickel plated. These alloys are hard and the nickel alloy has good resistance to acids.

Many of the metals that cannot be deposited from aqueous solution can be deposited from fused electrolytes, usually in the molten state. This is the method by which aluminum, magnesium, lithium and others are obtained. Metals that separate out below their melting points, as solids, usually consist of a loose aggregation of crystals or trees. Obviously, fused electrolytes are not of much value for producing coatings or for electroforming.

Another of the present trends in electrodeposition is the attempt to deposit metals in a smooth coherent form at ordinary temperatures from non-aqueous solutions of organic solvents. If metals such as tungsten, molybdenum, titanium and tantalum could be deposited, the coatings would find considerable use. The investigation of electrodeposition from non-aqueous solutions is difficult, but the rewards are sufficiently great that the subject will be continued and extended until all of the metals not now depositable from aqueous solution can be satisfactorily deposited. The most recent interest in the subject was aroused by research work in connection with the electrodeposition of aluminum from an organic solvent. Aluminum wave-guides have already been electroformed.

Electrodeposition on Special Surfaces

Stainless steel was once considered difficult to coat, but with suitable plating solutions of an acid nature, adherent coatings can be obtained readily. Procedures have been worked out for plating zinc base die castings with copper and nickel. Much research has been spent on attempts to produce adherent deposits on aluminum and today this is done on a commercial scale by first producing an adherent coating of zinc by chemical replacement which is then coated with the desired electrodeposit. The zinc immersion process has been extended to the deposition of coatings on magnesium and in time magnesium will be nickel plated commercially. The AEC have studied the deposition of several metals on beryllium. A need still exists for methods of producing adherent coatings upon some of the rarer metals such as titanium, tungsten and molybdenum.

A considerable trend has developed toward plating on nonconducting surfaces. While this has been done early in the development of electrodeposition, new procedures and applications have been developing. The plating of plastics was once a novelty but now they are plated commercially at low cost with copper, nickel or silver. The first step to the process usually involves the production of a thin film of silver on the surface by chemical methods, followed by electrodeposition of copper and other metals. A recent improvement in the process involves the spraying of chemicals to produce the silver film on the plastic.

Electrodeposition on plaster or rubber-like masters has been used for making metallic molds. Quartz crystals are coated with metal to vary their frequency. Where low weight is important, wood may be coated with metal. Sometimes metal is deposited on a nonconductor to serve as a surface for soldering or for a mechanical connection.

Bright Deposits

Bright nickel plating solutions now probably account for the largest part of the nickel plating done today. Brighteners have been developed for zinc plating to give it the eye-appeal of cadmium. Bright copper deposits and several bright alloy deposits, such as cadmium-zinc, bronze, speculum, copper-tin-zinc and nickel-tin have been produced.

Other methods of producing bright deposits have been developed. Electropolishing involves making a metal object anodic in certain solutions, such as mixtures of sulfuric and phosphoric acid. Under the right conditions, the metal comes from the solution mirror-bright. The method is used commercially mainly for stainless steel and aluminum and, to some extent, for brass. It can also be applied to electrodeposited coatings, for example, electrodeposited nickel, but thus far has not been utilized for this purpose to any extent, because the process removes too much of the deposit.

To overcome the objections of electropolishing, a combined plating and electropolishing process has been developed, called periodic reverse. The current is reversed at intervals while the object is in the plating tank, and the result is that thick, bright deposits can be obtained from plating solutions which normally yield dull deposits. The process has been successfully applied to copper and silver plating from cyanide solutions and is commercially used, but the application to many other types of plating solutions has not been worked out.

Special Engineering Uses

The production of metallic objects by electroforming is an old art, but there has been a consistent development of new uses for it. Such diverse objects as sieves, molds, computer cams, searchlight reflectors, waveguides, magnetic tape and pitot tubes have been economically manufactured by the process. Among the other engineering uses of electrodeposition are the building up of worn or undermachined parts. This has been done in England to a larger extent than in this country and deserves more exploitation as materials become more critical. For the atomic energy program, heavy nickel coatings are being produced on the inside of large steel tubes, and nickel deposition used to make porous diaphragms for gaseous diffusion.

A recent development is the production of porous chromium which holds an oil film, and is of use in engine cylinders and on piston rings. Where the economics of production require, objects can be stamped or formed from pre-plated sheet. The production of tin plated steel sheet and zinc plated steel wire in continuous lengths is carried on in large installations. The same procedures can be used for producing continuous sheets of steel coated with other metals.

There are two other factors that will have an indirect but large effect upon the engineering applications of plating. (1) The introduction of specifications into the plating industry has been accomplished in the automotive industry and has been instrumental in greatly improving the quality of plated parts on automobiles. The government has many specifications for plated products. The American Electroplaters Society and the American Society for Testing Materials have issued joint specifications covering many types of plating. The trend now is toward specification of plating. This means on the one hand that the consumer will obtain a more satisfactory product; on the other hand, it means that the engineer can no longer simply specify a metal, but will be required to know and specify the quality of the finish required. (2) Another trend in electrodeposition is the study of the electrodeposits themselves. The interest in this has been growing at an accelerated pace. Studies are being made by various groups on such subjects as determining the effect of chromium on the fatigue strength of steel. More knowledge of the properties of electrodeposited metals will enable engineers to adapt them for a large variety of purposes.

Metals Depositable From Aqueous Solutions

Commercially Important	Depositable but of Little Use		Questionable	Pure Alloys	Depositable from Fused Electrolytes
Cadmium	Antimony	Osmium	Columbium	Brass	Aluminum
Chromium	Arsenic	Palladium	Molybdenum	Bronze	Lithium
Copper	Bismuth	Platinum	Tantalum	Copper-Tin-Zinc	Magnesium
Gold	Gallium	Polonium	Titanium	Copper-Lead	
Lead	Germanium	Rhenium	Tungsten	Cobalt-Tungsten	
Nickel	Indium	Rhodium	Zirconium	Lead-Tin	
Silver	Iridium	Ruthenium		Nickel-Cobalt	
Tin	Iron	Selenium		Phosphorous-Cobalt	
Zinc	Manganese	Tellurium		Phosphorous-Nickel	
	Mercury	Thallium		Silver-Lead	
				Speculum	
				Zinc-Tin	

National Bureau of Standards

Larger Die-Cast Parts

Developments in the mechanical engineering and metallurgical aspects of the die casting process are responsible for most of the recent advances in this field – and this trend is expected to continue. Of the materials cast, zinc still represents the greatest volume – approximately 60 percent by weight – mainly because of the many zinc die castings used on automobiles and trucks. Aluminum now accounts for about 30 percent and magnesium is coming more into the picture, mostly in ultra-lightweight applications such as business machines and portable tools.

Mechanical engineering is responsible for recent physical development of the process as related to casting mechanisms and design of dies, tools and other equipment. Metallurgy accounts for many of the newer casting alloys, for satisfactory methods of alloy preparation and control, for advancements in finishing methods and for the solution of problems of inspection, control and treat-treatment procedures, all of which insure uniform, sound die castings.

Fig. 1 — Small zinc die castings are now taking the place of similar parts formerly made as castings, stampings or on a screw machine. Chain links are cast already interlocked and wires in the wiper-brush (lower left) automatically inserted.
Gries Reproducer Corporation

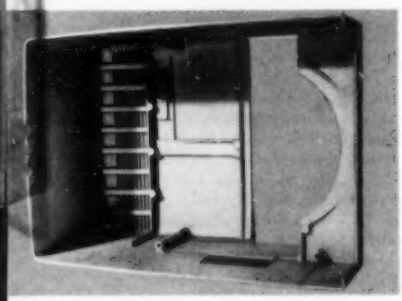


Fig. 2 — Magnesium-alloy (AM 263) dictating machine housing, measuring 8½ by 12 by 6 in., has average wall thickness of about ⅛ in. Relatively smooth as-cast surface requires very little finish.
Soundscriber Corporation and Aluminum Corporation of America

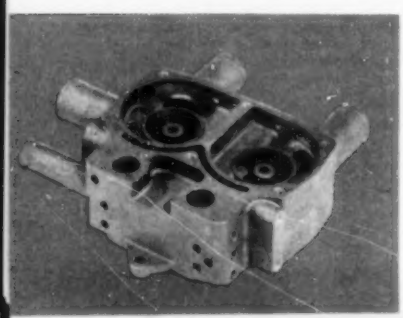


Fig. 3 — Dolcer air-distributor valve made of Alcoa 85X aluminum alloy incorporates sections having thicknesses that range from 1/16 to ½ in. Honeycomb passages illustrate complexity of shapes.
Eclipse-Pioneer Division, Bendix Aviation Corporation

Highly scientific methods for controlling alloy composition are being applied during the various phases of production, generally in the form of quantitative spectrochemical analysis. Though the equipment required is complex, the resulting economies are appreciable in the mass-production of close-tolerance die castings. Die steels are also being subjected to rigid controls, such as ultrasonic inspection, because the slightest defect in the die cavity is greatly magnified under pressure during repeated casting cycles.

Special alloys, refinement of die design and development of automatic machines have resulted in die-cast components that are both smaller and larger than those produced a few years ago. Many small parts, such as those in Fig. 1, are now being die cast instead of assembled from two or more stampings and/or screw machine parts, thereby conserving material and cutting the ever-rising costs of machining and handling appreciably.

Large die-cast parts such as the zinc radiator grilles on late model cars and the magnesium alloy dictating machine housing shown in Fig. 2, represent the advanced techniques now in use. The aluminum alloy air-distributor valve housing, Fig. 3, illustrates the complex shapes that can be obtained and the pressure-tightness that can be "cast" into a part.

With the development of larger, high-pressure die casting machines (which will have to have improved locking mechanisms), metallurgical controls and special die materials, the next few years will probably see even larger, more complex parts. These will incorporate a variety of features such as inserts and may well be made of materials not now associated with this process. An indication of this trend is the fact that serious thought is currently being given to the die casting of higher melting point alloys.

Flexible Dies to Improve Deep Drawing Techniques

Since World War II, several companies have been working independently toward lowering the cost of deep drawn metal parts. The methods of approach have followed two courses, both of which still require considerable refinement before one or both become generally accepted.

One approach is to stick with the basic metal punch and die technique, but to modify the forming members so that the sheet metal blank is subjected to a reverse draw, all in a single continuous stroke. To put it another way, a shallow cup is formed and then the cup is turned inside out as the draw progresses. A 12-gage, high-tensile steel blank of 40-in. diameter is currently being made into a cup that forms one half of a 14-in. diameter gas cylinder, Fig. 1. Diameter reduction is about 66 percent and the length-to-diameter ratio is almost 1.7 to 1. Dies for a 20-in. cylinder, the thickness of which will exceed the present maximum of about 0.110 in., are now available and serious thought is being given to 36-in. units. A special 1,500-ton press is now being designed for producing these large parts.

The second modification of the basic drawing technique is to replace the female die with a flexible member that conforms to the continuously changing contours of the blank. There are two types of flexible "die", one a rubber pad, which is typified by the Marform process, and the other a rubber-faced diaphragm, as used in the Hydro-Form technique. To date, Marform parts are generally larger, but of simpler shape than Hydro-Form units, Fig. 2, but with equipment of comparable pressure capacity and size, the capabilities of the two processes are generally similar.

Another difference in the two methods: Marform equipment is designed for attachment to existing hydraulic press equipment or as a feature of a conventional hydraulic press that can be used for punch and die or Guerin operations, as well as for Marforming. A special control is used for precisely regulating the rubber pad backpressure, thus controlling the amount of pressure exerted on the blank at any point during the drawing operation. Hydro-Form equipment is designed wholly for forming parts by this particular method only. Here, the diaphragm is backed up by hydraulic oil in which pressures reach maximum values of 15,000 lb per square inch.

Various grades of both aluminum and steel are applicable to these two processes. Sheet thicknesses range from 0.010-in. aluminum foil to 0.500-in. steel. Departure from the original sheet thickness is slight.

Compared to conventional deep drawing techniques, the flexible-female-die process has the following desirable features: (1) tooling costs are substantially reduced and the second-draw tools are often eliminated; (2) production costs can be reduced as much as 50 percent; (3) short runs show considerable economy because of inexpensive tooling and quick changeover features; (4) unusual shapes and segments can be accurately and economically formed; (5) tapered shapes can be drawn with greater slope and depth; (6) several different parts of complicated contours, each having similar pressure curves, can be formed simultaneously; (7) essentially uniform wall thickness is maintained in the drawn part; (8) surface finishes, both polished and coated, can be formed without damage; (9) strain concentrations are reduced in the formed part; and (10) annealing costs are less because the number of draws is reduced and in some cases annealing is eliminated entirely.

The advantages of these modified drawing techniques will no doubt be capitalized as soon as the specialized equipment becomes available.

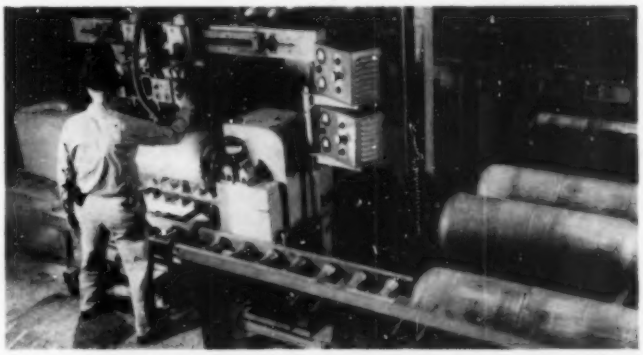
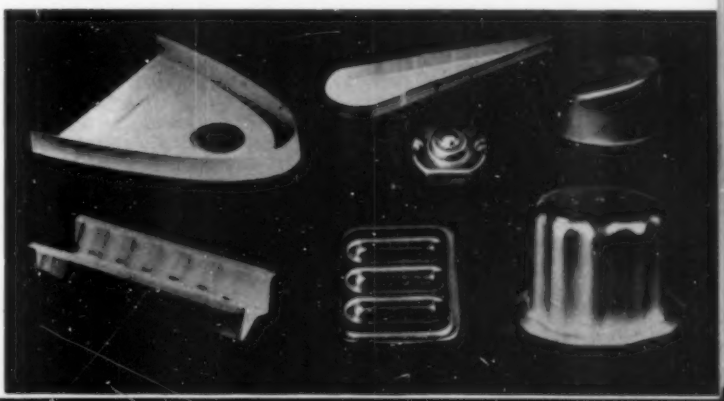
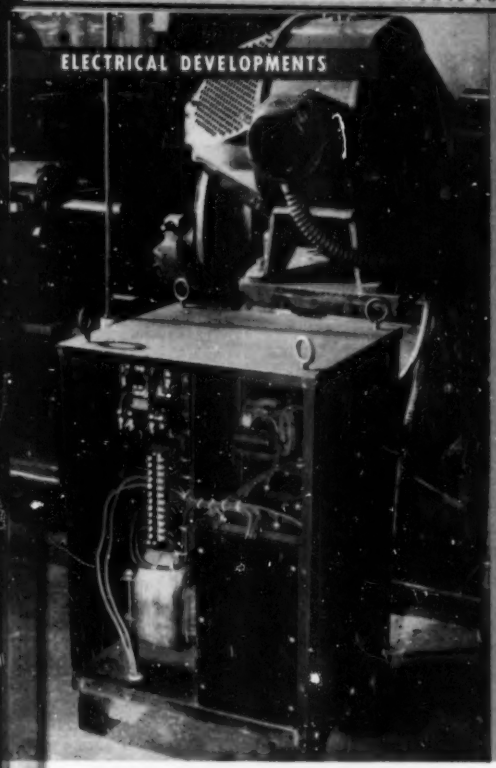


Fig. 1 — Each half of these 14-in. dia gas cylinders is formed in a single operation by the reverse-draw process. The welding machine at left completes the assembly. Scaife Company

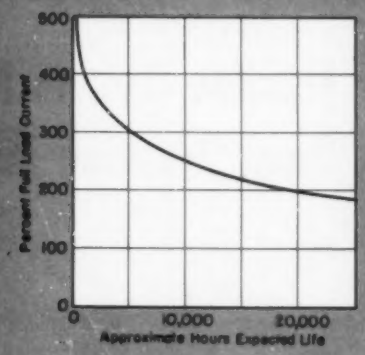
Fig. 2 — Typical shapes producible by either the Marform or Hydro-Form process. Hydropress, Incorporated





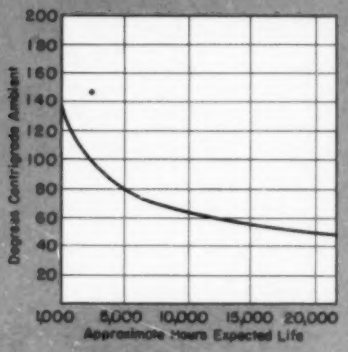
Machine tool (left) with individual selenium rectifier power pack. Trend is to use d-c drive motor and packaged rectifiers to replace a-c drives where speeds adjustable over a wide range are required.

Westinghouse Electric Corp.



Life characteristics of typical selenium rectifiers. Curve at left is taken at 25 C ambient and rated voltage. For curve below, voltage and current were held at rated. Temperature is critical factor limiting life. Present rating of 55 C ambient will be raised.

Westinghouse Electric Corp.



Semiconductors . . .

will become a major field of electrical engineering.

Semiconductors are relative newcomers to the field of product engineering. Because of the magnitude of current research programs, semiconductors may be classed as still being in the laboratory stage. Yet, the number of practical applications is already great. If the researchers have reasonable success in surmounting some of the problems they face, semiconductor technology promises to become one of the major branches of engineering.

Although the theories accounting for the behavior of semiconductors are complex, their chief peculiarity is clearly understood. A semiconductor has a high resistance to the passage of electrical current in one direction, while resistance in the opposite direction is comparatively low. This is immediately recognized as the property of an electrical rectifier. And, up to the present, rectification has been the most successful application of semiconductors. The semiconductors of most interest include copper oxide, various other oxides, selenium, germanium and silicon. Other peculiarities of semi-conductors arise from the dependence of their electrical characteristics on temperature (thermistor), light conditions (photo diode) and an impressed bias voltage (transistor).

Metallic Rectifiers

It appears probable that the selenium rectifiers of the reasonably near future will block as much as 75 volts per plate, will be suited for service at higher ambient temperatures and will be longer lived. Such characteristics are predicted by representatives of both military and private laboratories. The higher voltage rating per rectifier cell foretells wider use of metallic rectifiers from an economic standpoint. For a given line voltage, the rectifier assembly will be smaller and lower in cost. The commercial use of metallic rectifiers dates back to the early days of radio when copper-oxide assemblies were used to trickle charge batteries for home radios. In the years following, the application of copper-oxide rectifiers broadened to a diversity of higher power requirements. The selenium rectifier found wide acceptance at the beginning of the last war. Their lighter weight and the critical shortage of copper for copper-oxide rectifiers were the factors that spurred the use of selenium rectifiers. At first, the selenium rectifiers had a relatively short life. After the war, the selenium rectifier with its inherent advantages of less space, weight and cost was widely adopted for industrial purposes. At the same time, process advances brought about stability and long life.

Until 1947, the highest commercial selenium rectifier blocking voltage was 18 volts rms per plate. Now, at least one manufacturer, the Westinghouse Electric Corp., has made available rectifiers rated at 33 volts per plate. Blocking voltages as high as 45 volts have been achieved in laboratory specimens. The eventual goal is 75 volts per plate.

Applications

Small selenium rectifiers are widely used in electronic communication and control assemblies. Here, they replace fragile glass tubes. It is expected that with the increasing ap-

plications of magnetic amplifiers the manufacture of small selenium rectifiers will be expanded many times. A designer replacing electron tubes with magnetic amplifiers certainly will not select a tube for rectification. Second, the latest self-saturating magnetic amplifier circuits employ two or more selenium rectifiers to accomplish the self-saturating feature. In this regard, the low ambient temperature rating – at present in the order of 35 C – has been the subject of investigation by rectifier and magnetic amplifier manufacturers. Rectifiers for higher temperatures are already in the laboratories. Commercial versions should appear soon. Today, de-rating is a familiar practice of designers attempting to offset the temperature limitations of selenium. The engineer specifies a rectifier with a power capacity in excess of the actual requirements of the circuit. This uneconomical practice will be unnecessary.

Aside from control applications, selenium rectifiers appear more frequently in machine design. Individual power supplies furnished on industrial equipment such as machine tools make possible use of d-c drive motors regardless of the plant power supply. Thus, the availability of compact and low cost metallic rectifiers make it possible for the designer to apply the efficient speed control of d-c drives to a wider range of machines.

Most machine tools today are powered by a-c motors. Where extensive ranges of adjustable speeds are desired, it is necessary to incorporate expensive auxiliaries such as change gear boxes, variable belt drives or various types of slip couplings. The trend in many instances is to replace the a-c motor with the d-c motor and selenium rectifier combination.

Increasing use is being made of the selenium rectifier for battery chargers and d-c welders. The development of saturable reactor control circuits is one reason for the trend. With saturable reactors, the voltage output of the rectifier stack can be accurately controlled without high power losses. The selenium rectifier replaces a motor-generator set in one d-c welder. The elimination of the rotating machines lengthens the welder's service life. Since there are no friction and windage losses, the selenium rectifier welder has a full load efficiency of 66 percent compared with 54 percent in the motor-generator welder. Weight is only half.

High voltages are obtainable from selenium rectifier stacks. In large installations – such as a 11,500 volt, 5 amp rectifier for a radio transmitter – the overall size of selenium power pack is considerably smaller than other types of rectifiers. More applications are also forecast in high voltage, low current applications, typical of which is an electrostatic precipitator or air filter. One recent installation has a 70,000 volt, 70 ma selenium stack. Soon to be announced is a high power rectifier for 1,000 kw with plates measuring two by five feet.

Selenium rectifiers have interesting possibilities in small motor driven machines where constant speed is required on either a-c or d-c supply. Business machines are typical. In a voice recorder, for example, a governor-controlled d-c fractional hp motor is combined with a small selenium rectifier. Turntable speed is the same in both a-c and d-c locations. Another trend appears to be the use of selenium rectifiers in certain solenoid and relay circuits. This permits designers to adapt the d-c solenoids, which are faster acting and more sensitive than the a-c types, to a-c powered machines. Circuit breakers, milking machines, pinball machines and business machines are examples of applications for high-speed relays.

It is apparent that selenium rectifiers have advantages already being exploited by product engineers. Continuing research promises to improve these advantages further. It is safe to predict that many more of the forthcoming product designs will include selenium rectifiers.

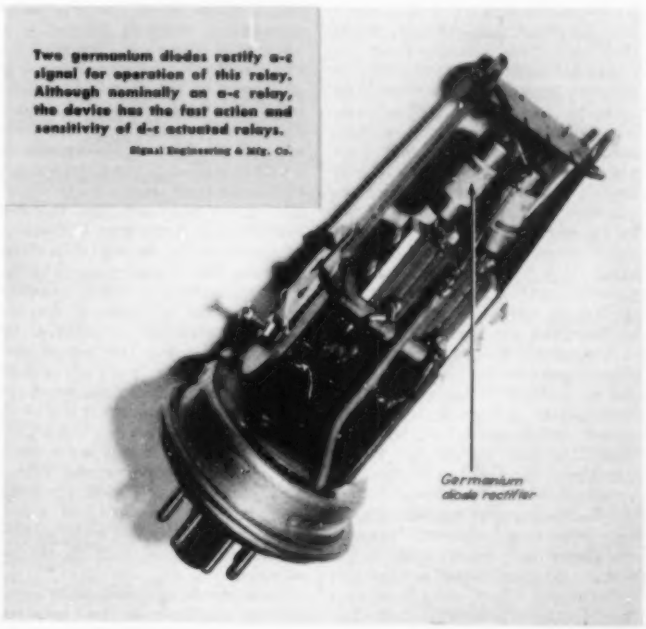
Germanium Diodes

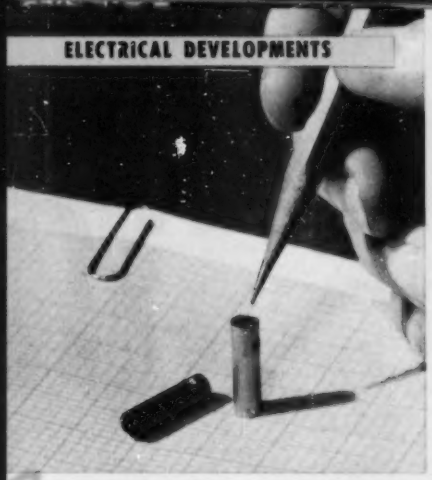
Miniature elements incorporating the semiconductor germanium are commercially available for use as rectifiers in non-power circuits. Large numbers already are in use in television circuits where the germanium diodes act as detectors and limiters. What their possibilities are in product design remains to be seen.

One manufacturer, the Signal Engineering and Manufacturing Co. of New York accomplished design of a sensitive and fast-acting a-c relay by use of germanium diodes. The diodes rectify the small a-c signal to realize the benefits of d-c relay actuation, which is inherently faster than a-c operation. The extent to which germanium diodes will be used in electronic machine controls or servomechanisms depends on the acceptance of miniaturization by industry.

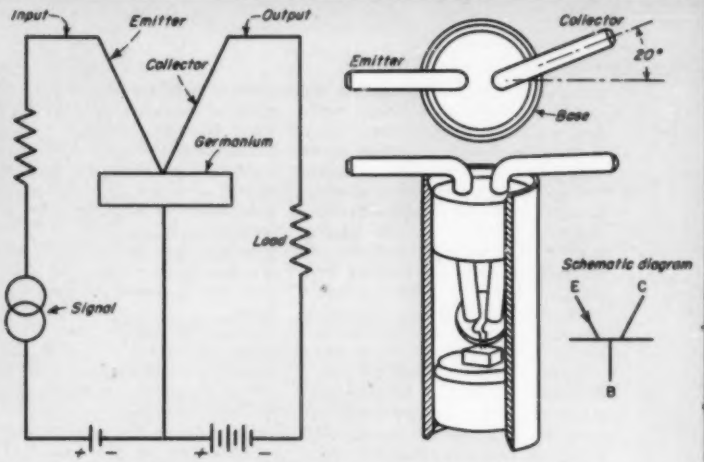
Two germanium diodes rectify a-c signal for operation of this relay. Although nominally an a-c relay, the device has the fast action and sensitivity of d-c actuated relays.

Signal Engineering & Mfg. Co.





Small size of the transistor is apparent in this photo. Transistors produce amplifications as high as 100 to 1 and are suitable for frequencies up to 10 megacycles per second.
Bell Telephone Laboratories



Cutaway view shows arrangement of parts in transistor. Schematic at left is typical circuit of transistor used as an amplifier. Load current is a function of the signal current, which actually modifies the electronic structure of the semiconductor.
Bell Telephone Laboratories

Vacuum Tubes to Transistors?

Transistors are in the stage now that electron tubes were in the early stages of their development. Some successful test applications have already been made but certain "bugs" remain to be eliminated. Means must be found to make transistors stable and uniform in characteristics before they can rival electron tubes as dependable product components Several laboratories are conducting research aimed at solving these problems. If the confidence of the engineers involved is any indication, transistors will eventually not only replace vacuum tubes in many applications but will open up new fields for electronics. Their expectations are reflected in the facetious boast of one: "When we get the transistor perfected and low enough in price, we'll have even electronically controlled wrist watches."

A transistor has several important advantages over the vacuum tube. It has no vacuum. It has no filament; consequently, it consumes no filament power and requires no warm-up time. It is both smaller and lighter than any commercially available vacuum tube. Within the present limitations of their power handling capacity, noise, and frequency response, transistors can perform many of the tasks now performed by vacuum tube triodes. They have been successfully demonstrated in radio-frequency, intermediate-frequency, and audio-frequency amplifiers, oscillators, mixers, and pulse generators.

Transistor Performance

In a transistor, two fine wires contact a wafer of the semiconductor germanium, which is soldered to a metal base. These parts are enclosed in a small metal cylinder. The points of contact of the input and output wires with the germanium wafer are only two-thousandths of an inch apart. A d-c bias of a few tenths of a volt is applied at the input contact in the forward (conducting) direction of the semiconductor. The d-c bias of 20 to 50 volts at the output contact is in the reverse (blocking) direction. The unique property of the semiconductor that makes possible its use as an amplifier is that its electronic structure is modified by the input current. Because of this property, the blocking resistance of the semiconductor is inversely proportional to the current at the input contact. This control of output current with input current is the basic mechanism of amplification. With a load resistance of 10,000 to 20,000 ohms and an a-c signal of a few tenths of a volt, power amplification in the order of 14 to 20 db can be obtained.

Since results of field tests on commercial applications are not yet available, the designer's evaluation of the transistor is confined to laboratory reports. These indicate that at present the transistor gain of about 20 db per stage is somewhat low compared to 30 or 40 db obtainable from audio tubes. Regarding stability, the transistor gives more trouble than a tube at low frequencies. At high frequencies, this difference is less marked if the transistor is compared with a triode instead of a pentode. The latter is of course better shielded than the transistor. Frequency response of the transistor is good up to 10 megacycles or more. The power output efficiency of about 30 percent is about equivalent to that of an electron tube. The noise figure of 60 db at 1,000 cycles is much worse than that of a good electron tube, which can approach zero db.

Among the factors favoring transistors are small size, low power drain, no standby power, instant starting response, low heating effect when used in large numbers and ruggedness. The life of transistors should be long judging from diode performance. Because of the mechanical simplicity, the designer can hope for low cost. While the transistor does not excel all electron tubes, it is already good enough for many applications and will be considerably better in the future.

Schematically, the transistor is simplicity itself. But the phenomena that occur within the germanium crystal are extremely complex. For this reason, progress in transistor development may be slow.

Thermistors

Thermistors, or thermally sensitive resistors, incorporate a type of semiconductor whose resistance decreases about four percent when temperature is raised one degree. In addition to sensitivity, the thermistor is small, stable and rugged. The semiconductors used are mixtures of manganese, nickel, cobalt, copper, uranium and other oxides. None of the semiconductor developments offer more possibilities to the product engineer than the thermistor.

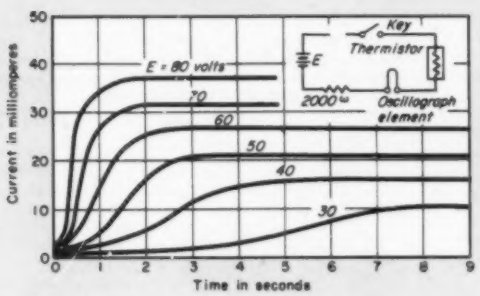
Current applications fall into either of two general types, depending on whether the thermistor responds to ambient temperature or whether it is resistance heated by the circuit with which it is associated. Temperature measurement, temperature compensation, and temperature control are examples of the first classification. When used as resistance thermometers, precision greater than that of thermocouples can be obtained. In temperature compensation, thermistors may be used to neutralize the effects of temperature variations in other electrical components, meters or conductors possessing positive temperature coefficients of resistance. This is demonstrated in a new inverter for aircraft power supplies manufactured by the Holtzer Cabot Co. of Boston. Feature of this inverter is its ability to supply alternating current at a fixed frequency, which is held precisely constant within ½ cycle. The inverter has equal accuracy from minus 60 to plus 120 Fahrenheit. Temperature compensation over this range of temperatures is achieved by use of thermistors.

A much larger number of applications should be found in the second field which makes use of the voltage-current, resistance-power and current-time characteristics of thermistors. One possibility is the use of a thermistor as a vacuum gage or flow meter. If a thermistor is heated directly by passing a current through it, its final equilibrium condition is affected by the transfer of heat to or from it. Heat transfer is in turn a function of air density or fluid flow. So sensitive is the thermistor that it can detect slight changes in vacuum pressure or flow rates.

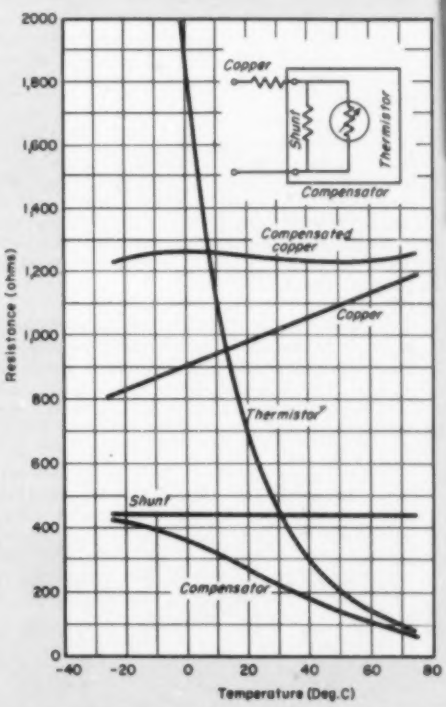
The time-current characteristics of thermistors should be of value in time-delay applications. The gradual lowering of resistance that results when a thermistor is heated by current passing through it, can be employed to delay operation of a relay or other electrically actuated mechanical component. Net time delays from a few milliseconds to several minutes can be obtained by suitable design and choice of circuits. The time-delay characteristic of thermistors may also be used to prevent false operation of relays or other devices caused by transient voltages. Thermistors can be designed to provide a thermal inertia. This, together with their high initial resistance, discriminates against high voltage surges of short duration. The selective action, however, will not interfere with the normal operation of the relay at lower potentials of longer duration.

In other applications, thermistors are being used as overload protectors, voltage regulators, switching devices, volume limiters in audio circuits and automatic volume or gain regulation.

Because of their versatility, thermistors offer intriguing possibilities in product design. Fire alarms, gas detectors and other types of safety devices can be built around thermistors. Closely allied to these are applications in pyrometry, chemical analysis and quality control. In the electronics field, thermistors can function as generators of low frequency a-c voltages, power modulators, oscillators, filters, amplitude stabilizers and modulators.

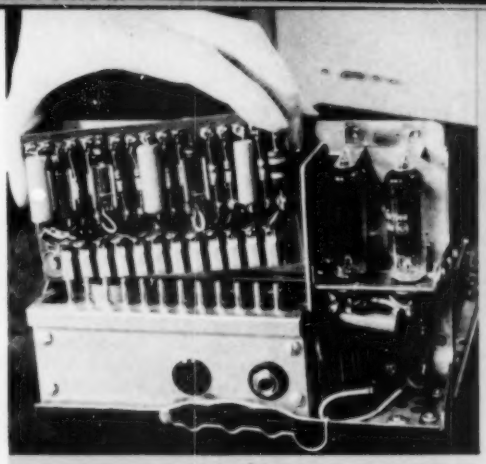


Current versus time curves for 6 values of battery voltage in the circuit shown in the inset. Thermistors can be used in series with relays to add a time-delay to a circuit.
Bell Telephone Laboratories



Temperature compensation of a copper conductor by means of a thermistor network. The winding with compensator has a resistance of 1,250 ohms constant to ±1.6 percent over the temperature range from −25 C to +75 C. Over this range the copper alone varies from 807.5 ohms to 1,192.5 ohms, or ±19 percent from the mean. Shunt resistor is temperature stable.
Bell Telephone Laboratories

Trends in Electronic Components and Constructions



Rear view of Soundscriber "Tycoon" recorder showing plug-in type card amplifier with subminiature tubes. Note sectionalized construction of chassis whereby high operating temperature components, such as power tubes, are isolated from electrolytic condensers, input transformer and other vital components operating at low temperatures.

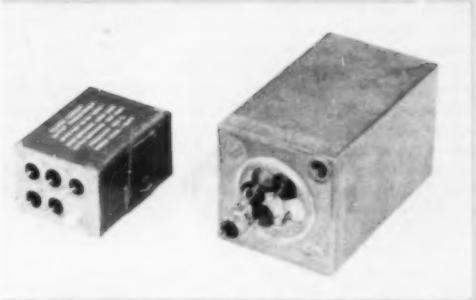
For the past twenty years, most of the engineering effort in military and industrial electronics was devoted to circuit design. Now, this effort is being diverted largely to improving components and construction techniques. With the vast increase in the use of electronic equipment, it has become apparent that the "home-radio" standards are not good enough for industry and the military. Here is a summary of the status and outlook for each of the improvement programs.

Premium Quality Components. This program is aimed at making electronic parts as dependable as other product components, such as bearings or motors. Guaranteed life and performance, not necessarily long life are the principal goals. Development is still in the early stages, although some quality components are already commercially available. Sylvania's "Premium Performance" and RCA's "Special Red" tubes are examples. All electronic parts – resistors and capacitors as well as tubes – are involved.

Subminiaturization program is in advanced stages. All electronic components are available in this size classification. Extensively used for military and special civilian products. No one can predict whether or not the subminiature elements of today will become the "standard" components of the future, since heat dissipation and electrical proximity effects are already critical problems in applications.

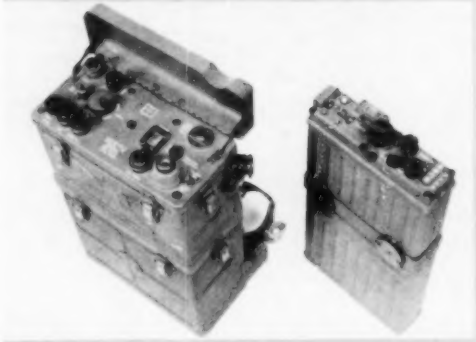
Unitization of circuits and components into compact plug-in packages is fast becoming standard practice. Service problem is eased considerably. Latest additions to the unitization picture are hermetically sealed and potted units, which afford protection against shock and atmospheric conditions.

"Printed" Circuitry is on the way up, but not in the sense that complete electronic equipment is being rolled out on presses. Most promising at present is the combination of standard components with stamped or printed wiring. Also, increasing numbers of individual circuit components are being made by stamping, printing, etching and allied processes.



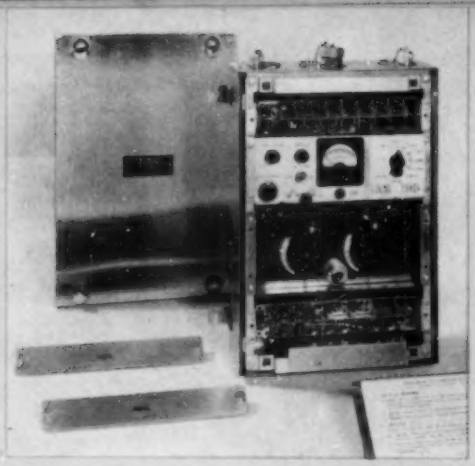
Subminiaturization program includes all electronic equipment components. Transformer at left is one-third the size and one-seventh the weight of comparable conventional transformer. New core materials, gas insulation and plated aluminum can are features of small transformer.

Eclipse-Pioneer Division of Bendix Aviation Corp.

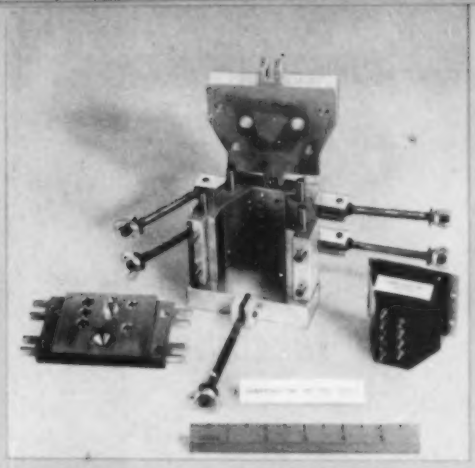


Walkie-Talkie shown before and after miniaturization of components. New model on right weighs 19 pounds against 38 pounds for older model, occupies about half the space, and has greater clarity and versatility.

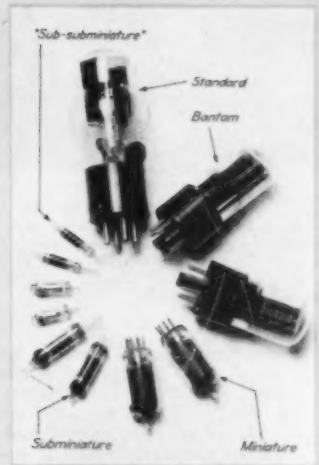
Signal Corps Photo



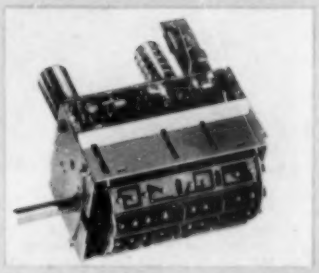
Cellular type of unitized construction is used in Motorola F. M. transmitter. Tubes incorporated in the removable cells are of the subminiature type. Packaged design simplifies assembly.

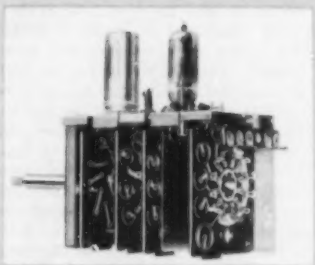


Potted subassemblies are rugged and sealed from the atmosphere. Potting is becoming major factor in unit construction. Potting materials have been improved. Cornell Aeronautical Lab.

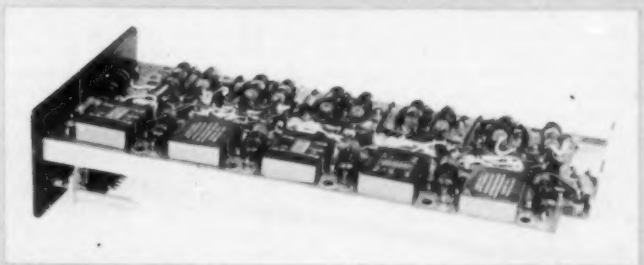


Somewhere in this picture the point of diminishing returns may have been passed. Even the smallest of these tubes are used extensively in special applications. But there is doubt whether today's subminiature will be tomorrow's standard. Heat dissipation, proximity effects and cost are among factors to be weighed against compactness of the subminiatures. Sylvania, Electric Products



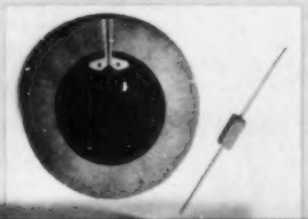


Production models of television tuners. Coils and circuits of Hallicrafters tuner at left are printed on insulating base with conductive inks. Franklin tuner uses stamped copper for coils and connectors. Both have been proved in service.

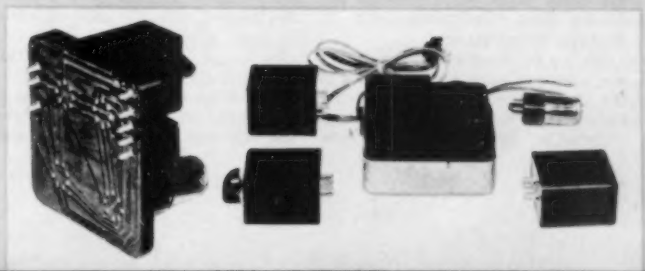


Card amplifier shown is one of fourteen plugged into a single case. Complete electrical and mechanical installation is accomplished by sliding the card amplifier into place and securing to the case with six screws. Bulpac-Pioneer Division of Bendix Aviation Corp.

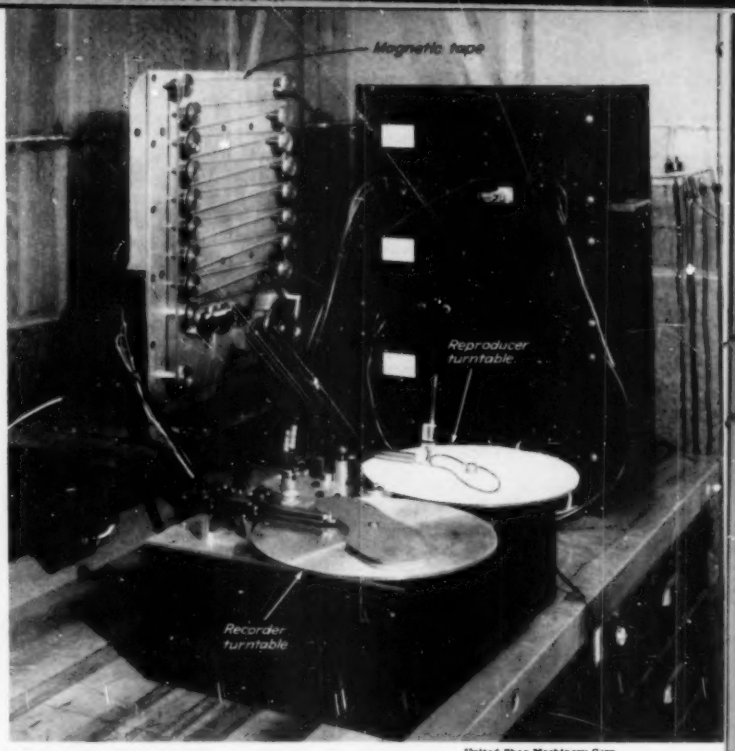
"Printed-circuit" techniques are presently finding much use in manufacture of components. Above, left, is potentiometer consisting of metal inlaid on phenolic base. Subminiature ½ watt resistor contains printed element of 1,000 ohms accurate to ±10 percent. Glass Products Co.



Circuit connections of this amplifier are sprayed on bottom of chassis, then coated with insulation. All components are standard types, assembled in plug-in units. Minneapolis Honeywell



Electronic Brains for Machines



United Shoe Machinery Corp.

Complete test set-up for the "magnetic cam." Movement of the follower around the wood block sets up square wave electrical impulses that are a function of the shoe contour. The impulses are recorded on a magnetic paper tape. When the tape is played back through a servo system, the reproducer stylus traces a shape exactly duplicating that of the wood block. Cabinet contains power supply, multivibrator, playback amplifier and servoamplifier.

To be automatic, a machine must have a "brain." Such brains involve two factors – a memory device and a means for translating the remembered function into action. Today, the brains of most automatic machines might be described as low level. Examples of machine brains are a cam (for memory) and associated mechanical linkages (for translation); a limit switch and its electric circuit; and a valve and its hydraulic system. These types are relatively slow acting and have limited retention capacity. Also, once constructed for a particular function, they are not easily adapted to another.

But brains that are both fast and flexible are now available for machine applications. These new types result from intensive development in the design of computers, automatic pilots, gunfire controls, business machines and like equipment. In general, these latest machine brains consist of electrical memory devices and servomechanisms. Table I gives a comparison of the speed, capacity and cost of the 9 types of memory devices under current investigation. Of particular interest to machine designers is the magnetic paper tape recorder or "magnetic cam."

Magnetic Cam

The infinitely flexible magnetic cam is the result of a new recording system called ratio-modulation. With this system, it is possible to precisely record and reproduce cam shapes or other contours with a magnetic paper tape. The magnetic cam is the work of R. R. Perron of the United Shoe Machinery Corp. in Beverly, Massachusetts.

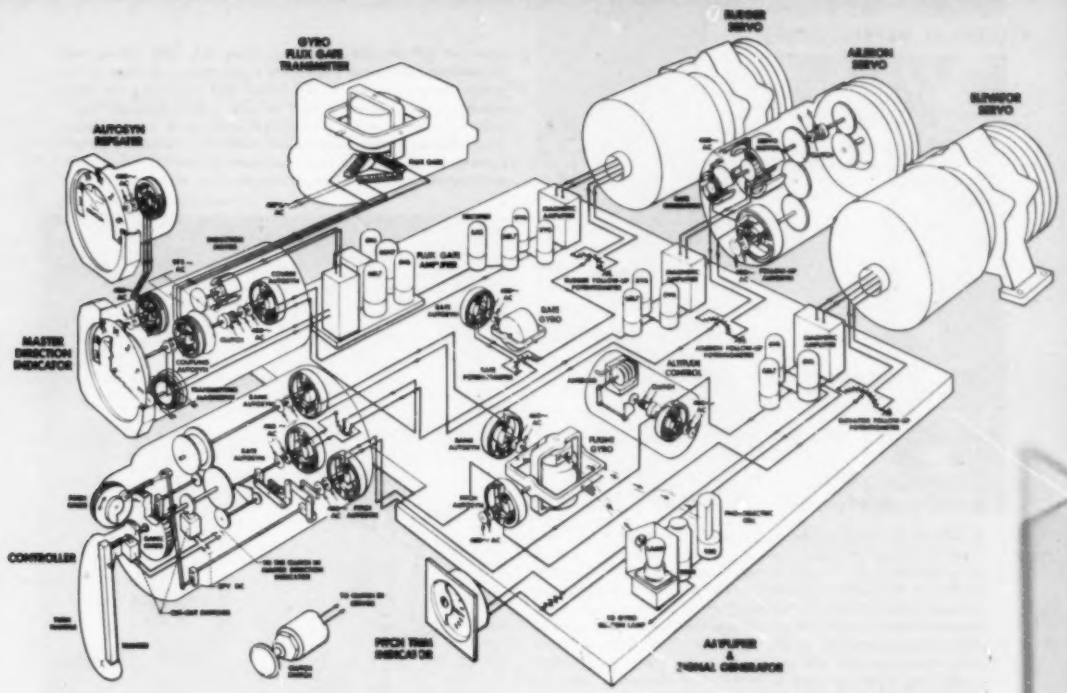
During development, it was found that amplitude modulation, which is the most widely used system for the recording of speech and music, was unsuitable. Distortion arose from changes in the recorded amplitude because of factors such as noise and demagnetization effects and also the difficulty of recording and reproducing cam dwells with an amplitude modulated carrier. Frequency modulation would overcome these difficulties, but would be subject to distortion caused by fluctuations in tape velocity.

In ratio-modulation, a square wave is modulated so that the ratio of the length of the positive square pulse to the total square wave cycle is a direct function of the intelligence. Since the intelligence is recorded in the form of a ratio, changes in amplitude of the recorded pulses or changes in tape velocity (up to ± 30 percent) produce no perceptible distortion.

The contour sensing element of the recorder mechanically changes the setting of a variable capacitor in each of the two time constant circuits of a multivibrator. This differentially varies the length of the positive and negative pulses of the square wave output. Thus, when the duration of the positive pulse is decreased a given amount, the negative pulse is increased a like amount, and vice versa. The recording head coils are connected in the cathode circuits of the multivibrator.

Commercial grade magnetic recording tape driven at 1¼ fps was used in the test model recorder. This was satisfactory for 1,000 playback cycles. The tape was friction driven. Machine installations require a perforated sprocket driven tape to maintain tape velocity in direct synchronism with the machine cycle. Beyond 1,000 cycles, the contour reproductions show some irregularities from wearing off of the magnetic coating medium, usually only 0.0005 inches thick. The development of a suitable steel tape will extend the number of playbacks to an almost infinite number.

In the contour reproducing apparatus, a flip-flop circuit is required to reconstruct square waves which are replicas of the originals. This circuit is needed because voltage peaks are generated by the square wave tape flux passing by the reproducing head. The square



Eclipse-Pioneer Division of Bendix Aviation Corp.

One of the current developments that forecast the coming of machines that think. To hold an airplane on a given course at a set altitude, the Bendix PB-10 Automatic Pilot duplicates some functions of the human brain. Any changes in the trim of the plane, wind direction and velocity or other factors affecting flight of the plane are reflected in the instrument readings. The instruments feed directly into the servo system, which instantly calculates how the plane's controls must be adjusted to compensate for the changes. The adjustments are made instantaneously. The treacherous human element is eliminated also.

wave flip-flop output is then averaged by a filter and the resulting d-c voltage output becomes a direct function of the original contour intelligence. This voltage is fed to a servomechanism that positions a stylus or tool in accordance with the desired objective.

Although precision was not a prime objective in the design of this magnetic contour recorder, an overall accuracy of ½ of one percent was readily attained. The accuracy of such a system is obviously a function of not only the magnetic recording system, but also the servomechanism performance. The servo used in the apparatus was all electrical. In a machine application, either a rotating amplifier or electro-hydraulic servo could be used.

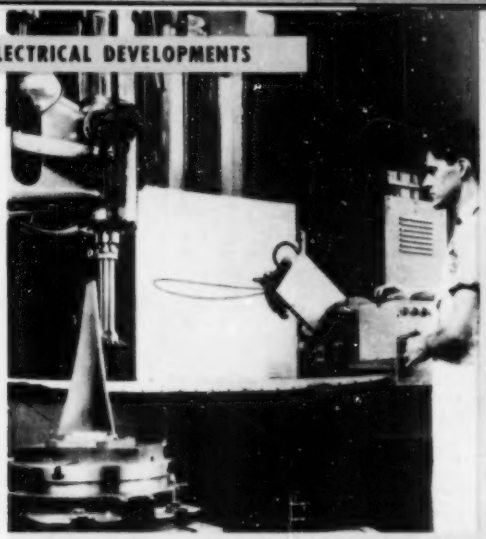
Makers of business machines and computers up to now are leading users of the new type memory devices. Most familiar is the line of punched card machines made by International Business Machines Corp. This firm has also investigated the possibility of using the card system for control of other types of equipment. General Electric in Schenectady made considerable progress in the design of a lathe that is governed by a magnetic wire recorder.

Electronic tubes are the choice for most of the latest computer designs. They are the fastest operating of the memory devices. However, the amount of intelligence a tube can retain is limited. Hence, vast numbers of tubes are involved in some installations. The power supplies and cabinet space needed are correspondingly huge.

Perforated rolls of paper, similar to those that actuated the old-time player pianos, have a place in modern design. A machine employing such rolls types individual copies of form letters that are even addressed to the names on a mailing list – all automatically. A much more complex development is that announced by the Arma Corporation of Brooklyn, New York. This consists of an analogue computer that reads information from a perforated paper roll and transmits a control action to a slave machine. In a demonstration of the "Arma-Matic" device in conjunction with an engine lathe, a short stepped shaft was machined to an accuracy of ± 0.0003 in. on the diameters and ± 0.0025 in. on longitudinal dimensions.

A somewhat similar development is underway at the laboratories of the National Advisory Council for Aeronautics in Cleveland. Magnetic tape is used as the memory device in place of a paper roll. In an experimental set-up, the tape recorder and computer controls the machining of complicated contours -- jet engine turbine blades, for example. NACA's aim is to have the computer aid in designing the product as well as governing its manufacture. Signals representing the formula for a complex shape can be recorded on the tape. The computer takes this information and converts it to workable data, such as would be embodied in an engineering drawing of the part. The computer then passes these data along to the lathe in the form of control signals.

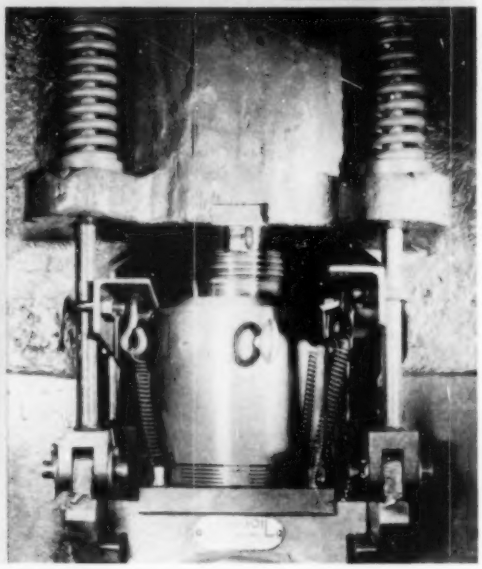
Applications of these devices are not confined to lathes. Systems for



A machine tool that can read a blueprint. The Pratt & Whitney Aircraft contour follower uses an electronic assembly (linked to a standard jig borer). A cross sectional metal drawing of the air-foil contour desired at any particular point in the master turbine blade is scanned by a photo-electric eye. Impulses from the scanning head are fed into a servo system controlling operation of the jig-borer. This machine faithfully reproduces the airfoil contour in the metal blank from which the blade master is made. The electronic contour follower cuts the cost of a single blade master from over 4,000 dollars to 100 dollars. The time required to make a blade master was reduced from 6 months to 3 days.

Load cell of 200,000-lb capacity used in a cold rolling mill for making steel strip. The unit is supported on springs which permit removal of the rolls without also removing the load weighing unit. Measurement of roll loads depends upon resistance wire strain gages cemented to a steel column which transmits the load to the rolls. An electronic circuit detects changes in electrical resistance of the fine wire grids and translates them into a meter reading or control action.

The Baldwin Locomotive Works



generating master cams, positioning of the work-piece on jig-borers and for precision grinding are also under development.

Electrical Servomechanisms

The second function of a machine brain involves the interpretation of the intelligence stored in a memory device. Up to the present time, designers of complicated automatic equipment favor the electrical servo system because of its speed of response, flexibility and accuracy. The bulk of research on electrical servos has been for application in military equipment and in the field of aviation.

The high cost of the equipment itself as well as the intricacy of the technology involved have prevented the widespread adaptation of servo systems to industrial uses. But the hindering factors are being lessened. First, prices will become more attractive with increasing production and standardization. Then, designers are becoming more convinced that the gain in performance may well offset the cost of a servo system. At the same time, engineers specializing in servomechanisms are in greater number and published information on the subject is available for study.

Electrical servomechanisms are used in the Arma, General Electric, NACA and United Shoe Machinery Corp. projects previously described. In each case, there are certain computations that must be done between the memory device and the performing of the action. The performance of electrical servos has been proven in a considerable number of computer designs, both civilian and military.

Electrical servos can be used not only to extract information from memory devices but also to interpret signals from sensing devices. Thus, servomechanisms can be designed to react to changes in temperature, light, position, pressure, dimensions and other variables. It is in this role that electrical servomechanisms have found widest use in industry up to now. The industries requiring continuous process control are daily finding new applications for servomechanisms. The chemical, oil refining and metal producing industries are typical.

In process control, servomechanisms may serve as remote indicating systems. Variables measured at inaccessible or hazardous locations can be brought out to a convenient panelboard. Or elaborate servomechanism systems can evaluate several variables in a continuous process to insure a consistent end product. Any deviation in the characteristics of the product can be detected instantaneously and the system will initiate an appropriate control action to correct the condition. In the production of certain liquid chemicals, for example, servo systems will keep a constant watch on factors such as the temperatures at various stages, color of the liquid and density.

It is likely that the future will find similar systems applied to machine design. An automatic machine tool, plastic molding machine or welder could be furnished with a servo system to continuously monitor the quality of the product. Imperfect surface conditions, dimensions or tolerances will be detected and corrected automatically. The servo system promises much in the field of quality control.

Westinghouse Electric Corp. is exploiting a computer-type servomechanism system to regulate fuel

flow in the J-34 jet engine. In a jet engine, two variables determine the efficiency of fuel consumption at each specific thrust setting. These are engine speed and combustion-gas temperature. Under flight conditions, it is impractical for the pilot to work out for each thrust condition the most favorable combination of these variables. The servo "brain" eliminates this necessity by evaluating automatically four signals – one from an exhaust thermocouple, another from the turbine tachometer and two from the pilot's throttle. If the combination of variables is not the best for least fuel consumption at the thrust called for by the pilot, the control directs the proper corrections to be made.

There is a trend toward reducing the size of servos. This is an advantage especially to machine designers since the enclosure for a complicated servomechanism control assembly might approach in size the machine itself. Another trend that will aid the greater use of servos is the development of components for 60 cycle power supplies. Up to recently, 400 cycle equipment – standard for military, shipboard and airborne installations – was the rule. Many civilian designers who grew up with 60 cycle apparatus are somewhat prejudiced against changing to 400 cycle circuits. Another deterrent is the prevalence of the 60 cycle electrical supply throughout industry.

Transducers

The application possibilities of servo controls have been broadened considerably by the perfection of new types of transducers. These devices change energy of one form or another into an electrical signal that causes the servomechanism to react. Transducers now available can duplicate any of the 5 human senses. Potentiometers, synchros, variable impedance coils, differential transformers, thermocouples, resistance strain gages and capacitance pickups are among those commonly used.

One of the older sensing elements, the photoelectric cell, is being used by the General Electric Co. in experiments on a contour-following system. The system is intended to control a machine tool and, in effect, gives that tool the ability to read a blueprint. The lines of a drawing can be duplicated directly on metal stock. As the photoelectric cell moves over the drawing, electric impulses are sent to a servomechanism that controls the lead screws of the machine tool. When the eye shifts, the cutting tool is shifted correspondingly.

Table I — Comparison of Memory Devices

Type	Access Time	Capacity	Cost Per Binary Digit
Punched card or punched tape	0.1-1 sec	400 digits per card or 100,000 digits per reel	.003¢
Magnetic wire or tape	3 millisec minimum	10,000,000 per reel	.001¢
Relay	3 millisec	1 digit	$1.00
Magnetic Drum	100 microsec	100,000 to 1,000,000	2-10¢
Acoustic delay line	100-1,000 microsec	200-1,000 digits per line	$1.00
Electrostatic	1-20 microsec	256 digits per tube	50¢ to $1.00
Vacuum Tube	.01 to .1 microsec	1 digit	$5-$10
Magnetic flip-flop	20 microsec	1 digit	$2.00
Photographic Film	.1-1 sec	5×10^7 reel	.001¢

Table — courtesy National Bureau of Standards

The photoelectric eye follows the drawn lines without directions from a human operator. The eye scans the line of a drawing through a low-power microscope at speeds up to 6 in. per minute. When the line is in the center of the microscope's field of vision, the electric eye generates an electric signal. This signal is monitored by an electronic circuit. If the microscope attempts to leave the line, the electronic circuit sets mechanical guides into motion to bring the microscope and electric eye back into position. G. E. engineers say that the instrument does not vary from a drawn line by more than three-thousandths of an inch. It can follow a loop with a diameter as small as 0.06 inch.

Increasing use will be made of strain gages, which have the ability to detect very small motions. This factor makes them ideal sensing elements for servo systems. A variable impedance coil can translate the minute movement of a bimetallic thermostat, bourdon tube, bellows or a load ring into an electrical signal. These sensing devices are already widely employed in the processing industry. Indicative of the possible applications in machine design is a fatigue tester in which a constant load is automatically maintained on the specimen. The coil-type strain gage measures the mean deflection of the vibrating specimen. When the specimen weakens, its deflection increases and the spring load tends to drop. However, the gage detects this and acts to increase spring tension through a servo control circuit.

Accurate control of rotational speed is a field for speed-sensitive transducers and associated servomechanisms. Latest application of such devices is in the Westinghouse electronic governor. The governor is for use with electric generators driven by steam turbines, diesels or gasoline engines. Basic part of the electronic unit is a frequency network that detects any variation from the desired frequency of the generated electric power and provides a signal proportional to this deviation. This signal voltage is operated by a stability network and amplified to actuate a solenoid cup valve. This valve is the connecting link between the electronic system and the hydraulic servo that regulates the steam flow, gasoline carburetion or oil injection. A similar device could be adapted to turbines or engines that are not used to drive power generators. A small tachometer generator coupled directly to the output shaft will provide the signal needed to feed the electronic system.

One of the latest pickups is an electron tube that is sensitive to forces of acceleration. In this tube, either the plate or grid is spring mounted. When the tube is fixed to a moving body, any change in the speed of that body causes the spring-mounted tube element to deflect. This action changes the tube characteristics momentarily, with proportional change in plate current. This tube can be incorporated in an electronic circuit for direct measurement of the rate or forces of acceleration. Or, the tube can be coupled to a servo system to initiate a control action when a predetermined rate of acceleration is reached or exceeded.

With this impressive start already made, the age of complete automaticity of machines should not be far.

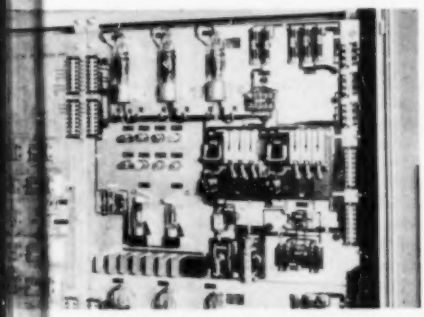
Coming: More Adjustable Speed Drives

There is a definite trend toward greater use of adjustable speed drives in industry. Offsetting its greater cost, an adjustable speed machine has these advantages:

(a) Versatility. The machine is not tied to one specific job function.

(b) Improved quality control. In many operations, speed is a critical factor affecting product uniformity and quality.

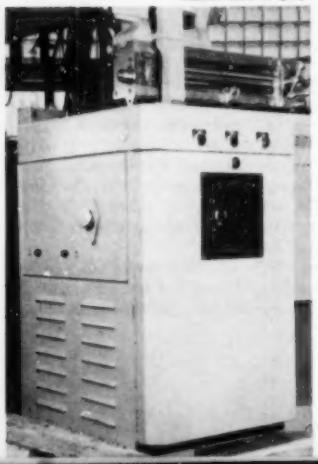
(c) Simplified operation. Adjustable speed drives make practical the design of automatic machines that require a minimum of operator skill and are not subject to the "human element" variable.



Section of Cutler-Hammer control for a machine tool, showing extensive use of electronic and magnetic devices. Speed adjusting, timing, indexing, interlocking and protection circuits are among those included in the cabinet.

Adjustable voltage d-c drive on a Rivett Type 608-PV lathe. The control is a combination of an adjustable Variac transformer with a selenium rectifier supplying variable armature voltage to a 1½ hp d-c motor. Operator regulates speed by moving dial knob on front of cabinet.

General Radio Company



Adjustable voltage d-c motor drives are the most commonly employed and are still gaining in popularity. This drive offers a wide range of speeds, accurate regulation, regenerative braking and easy reversing. The bulk of current applications of d-c adjustable speed drives are in plants with a-c power supplies. Available from many manufacturers are packaged controls that include some type of current rectification as an integral part. Adjustments in motor speed are made by regulating rectifier voltage and the motor field. Small drives, up to about 30 hp, employ thyratron tubes for rectification. For larger sizes, mercury-pool tubes (ignitrons) are used. Drives of these types are in service on such diversified applications as fractional horsepower machine tools, 200 hp printing presses and 18,000 hp steel mills.

Similar packaged controls incorporate selenium rectifiers. Two developments point to increased popularity of this type control. First is the constant improvements being made in the metallic rectifiers themselves. Second, the saturable reactors and magnetic amplifiers now available make it possible for the first time to vary the voltage of a metallic rectifier efficiently, without extensive power losses in resistors or like components.

The motor-generator Ward-Leonard system of adjustable speed drive is finding still wider usage. Such equipment in small and medium sizes (up to 200 hp) is now available as an integral machine component. The motor-generator and suitable control are factory assembled in cabinets of various designs.

Although not in itself an adjustable speed drive, the rotating amplifier is being viewed with increasing interest by the machine designer. Used as an electrical lever, this device takes a conveniently small control signal and amplifies it so that it can operate much larger power circuits. The rotating amplifier is often employed to control the generator field excitation in the motor-generator type of adjustable voltage d-c drive. The speed of the drive motor is a direct function of the minute signal current that is fed into the amplifier. Characteristics are fast response, stability, high amplification and the ability to respond to a combination of inputs.

D-c motors operating from constant potential d-c supplies will continue to hold a prominent position in the field of adjustable speed. Today, in fact, their number greatly exceeds that of the adjustable-voltage d-c drives. Through control of field excitation, the speed of a constant potential d-c motor can readily be adjusted over a 4:1 range. Speed ranges as great as 8:1 are feasible. These d-c drives and their controls have excellent characteristics. While not as flexible as the adjustable-voltage systems, they are better than anything offered for this purpose in the a-c motor line. Motor-generators or rectifiers are employed to provide the d-c supply for these motors. In any particular installation, the choice between constant potential and adjustable-voltage d-c drives will depend on the weighing of economics against desired performance.

Although the d-c types of adjustable speed drives will be dominant in the developing world of highly automatic machines, the straight a-c drives will be applied in greater numbers also. These are less flexible, but less costly as well. Best performing of the a-c adjustable speed drives is the brush shifting motor. Speed ranges of 4:1 for continuous operation and up to 20:1 for intermittent operation are obtainable. Limited speed adjustments are possible with the wound-rotor a-c motor with variable external resistance. This motor is most suitable for varying or constant torque loads over a 2:1 speed range. Regulation varies from about 5 percent at high speed to 100 percent at minimum speed. Although a drive based on the wound-rotor motor lacks most of the features of a full-fledged adjustable speed drive, its low cost will make possible extending some of the benefits of adjustable speed to a greater number of machine applications. This same is true of multi-speed a-c motors, offering a choice of either two or four fixed preset speeds.

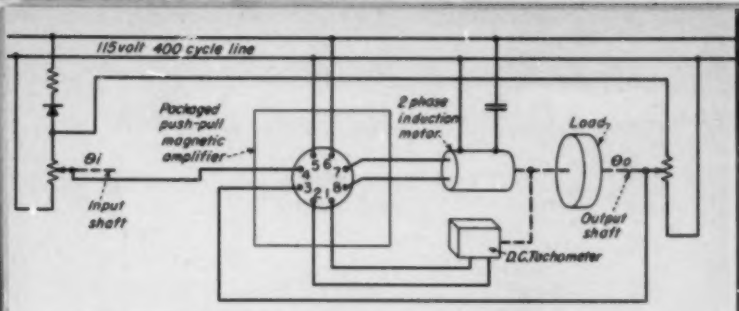


Fig. 1 — No tubes are required for this position servo system. Packaged push-pull magnetic amplifier steps up error voltage. Referring to the schematic, when input shaft is rotated, input potentiometer produces electrical signal proportional to shaft rotation. The difference between this voltage and the signal from the output potentiometer resul.. in an error voltage. This is fed to the magnetic amplifier, which produces a power output to the motor. The motor turns in a direction to reduce the error voltage to zero. The d-c tachometer serves to stabilize the servo system and prevent hunting. Magnetic Amplifiers, Inc.

The Prospects for Magnetic Amplifiers

At the present stage of development, the magnetic amplifier is of more practical use to the machine designer than to the radio engineer. At frequencies above the audio, the magnetic amplifier cannot compete with the electron tube in cost, performance, weight or size. If the magnetic amplifier is destined to supplant all vacuum tubes, that time is certainly not now in sight. It is in the field of machine control, servomechanisms and industrial control that the magnetic amplifier is being put to wide and ingenious use.

The magnetic amplifier uses the saturation characteristics of ferromagnetic materials to achieve power amplification in the order of millions. Its advantages over vacuum tube or thyratron amplifiers are:

1. Ruggedness – no glass tubes, no contacts, no moving parts.

2. High efficiency – no standby power consumed, no B-supply, no filament supply.

3. Instant operation – no filament warm-up.

4. Long life – life expectancy similar to high grade transformer components.

The major deficiency in performance of the magnetic amplifier as compared to other amplifier types is in speed of response. For extremely high power amplification with a low impedance input the time required for control is comparatively long. But if a high frequency alternating current is employed, the energy that must be stored during each cycle will be less and a higher speed of response may be obtained from a given control circuit.

One broad use where advantage can be taken of the magnetic amplifier is in stepping up signals from transducers. In the control of high voltage (500-600 v) motors or other electrical equipment, a magnetic amplifier can replace conventional control transformers; this assures the safety of the operator since pushbuttons, rheostats, and other components are on the low voltage signal side of the amplifier.

For military applications, some of the characteristics of magnetic amplifiers are ideally suited. They are much more resistant to shock – a big advantage on shipboard, for example, where great numbers of complex motor controls are employed. Already, magnetic amplifiers are widely used in military servo systems, especially in aircraft.

But applications in private industry are already extensive. Westinghouse Electric Corp. has developed a control circuit for squirrel cage induction motors with performance at least equivalent to the best adjustable speed d-c drives. This control is not yet in production but is under field test on trolley cranes.

A highly-refined and packaged adjustable-speed control unit for the operation of a d-c drive motor from an a-c line has been developed by the Louis Allis Co., using magnetic amplifiers furnished by Vickers Electric Division. A schematic circuit of this control is shown in Fig. 2. The unit includes a motor-generator set which converts the a-c power to direct current for the drive motor. To effect a change in speed below the base speed of the drive motor, generator voltage adjustment is provided. This is accomplished by adjustment of the control field of a magnetic amplifier

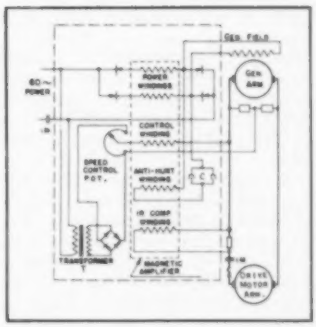
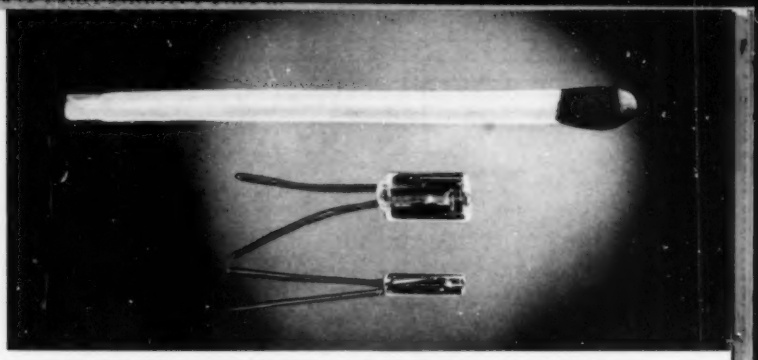


Fig. 2 — How the Louis Allis "Select-A-Speed" drive operates. Magnetic amplifier controls the voltages impressed on both armature and field of the d-c motor.

that supplies the generator field current through a bridge-type dry plate rectifier. Thus, by adjustment of a small potentiometer type rheostat, the generator field strength is altered resulting in a change in the voltage supplied to the drive motor. Any change in the drive motor applied voltage will result in a change in its speed.

In the speed range above the base speed of the drive motor, the applied voltage must be held constant and the field strength of the motor altered in order to effect a change in speed. A magnetic amplifier is again used to supply the motor field current through a bridge type dry plate rectifier. Through adjustment of the current in the control winding of the motor field magnetic amplifier, the motor field strength, and consequently the motor speed, is changed.

New Uses for Germanium Photocells



Germanium photocells compared in size to ordinary wooden match stick. The new cells can be mounted 100 to the square inch. This compactness, together with the fact that amplifiers are not required, benefits designers of calculators and tape reading devices. New uses for photocells should be opened also. Sylvania Electric

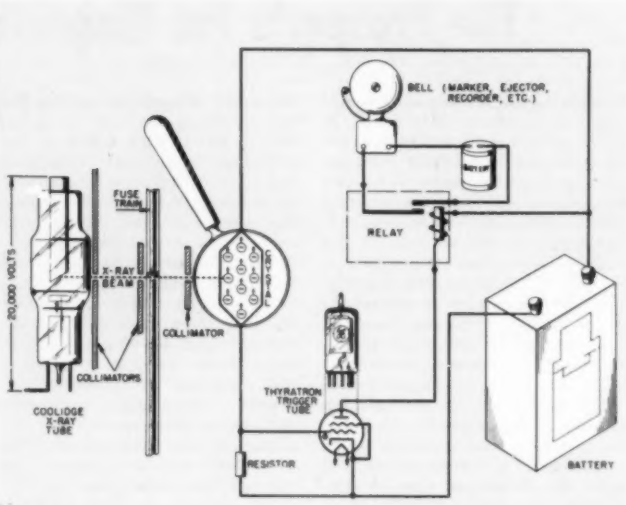
Miniature photocells are another semiconductor development. It has been found that the conductivity of germanium varies with light conditions. If the amount of light on a germanium wafer is increased slightly, its conductivity is stepped up greatly. When placed in an electric circuit, the germanium photocell will control the current in that circuit as a function of the light conditions.

In addition to its small size, the new photocell delivers considerably more power than conventional photo-electric devices. In some cases, this power is enough to operate a relay directly without the preliminary amplification usually required. This feature will benefit the designers of some type of calculators where photocells are used to read code perforations on cards and tapes. In a large installation as many as 100 electric eyes may be involved, each with its own power pack and amplifier. A tremendous reduction in the bulk of the apparatus can be achieved by using the germanium photocells, eliminating the need for most of the electronic equipment.

Because of their small size, long life and anticipated low cost, germanium photocells should find many applications where it is not now practical to use conventional photo-electric devices. The new cell is particularly sensitive to the wavelengths of light given off by ordinary incandescent light bulbs and will operate with these easily available sources with good fidelity. Germanium photocells are also responsive to light waves in the infrared region. This property might be exploited in communication via infrared waves.

Much investigation of the uses for germanium photocells is in the field of equipment such as telegraph, teletype and stock "tickers" using punched tape. Conventional electric eyes are not practical here. If germanium photocells are employed, the light source can be as strong as desired so that a signal of fifteen volts can easily be obtained across a 50,000 to 100,000 ohm load with a 50 to 75 volt supply. The cell can follow intensity variations as great as 10^5 per second – more than adequate for practical tape or disc speeds. The small dimensions (0.08 in. x 0.5 in.) of the molded cell make it possible to mount them as close as 0.100 in. on centers both parallel to the tape and across it. The small cells can be mounted a hundred to the square inch.

Other projected applications of the germanium photocell include its use in fire detection, automatic lighting controls, soundtrack pickup, signaling and the like. In the last two mentioned, the question of signal-to-noise ratio obtainable and the amount of light required at the lowest useful ratio are of major importance. Bell Telephone Laboratories, Sylvania Electric and the General Electric Co. are doing intensive research on germanium photocells.



Schematic of automatic x-ray inspection machine employing a semiconductor detector. When excited by x-rays, the semiconductor crystal releases a signal that can be used to operate warning devices or control mechanisms. Because of the million to one power gain effected by the crystals, they can replace much more complex systems involving large amplifiers with a considerable saving in cost.

Growth Industries of the '50s

Mobilization will bring rapid expansion of our basic industries: steel, aluminum, chemicals, power, transportation. Looking further ahead, peacetime markets for cars and trucks, industrial and agricultural machinery, and household appliances are still growing. An analysis by the McGraw-Hill Department of Economics of trends and future possibilities in industrial growth.

Mobilization has made one thing clear: The U.S. economy will have to grow and grow fast. It will take more steel, more power, more capacity in many lines to turn out planes and tanks, as well as an adequate supply of civilian products.

Rearmament is not the only reason we are growing. A study made before the Korean War broke out indicated that total national output would increase about 20 percent if a normal economy prevailed for the decade of the '50s. What rearmament has done is to accelerate the growth and concentrate expansion in lines that support our defense effort.

It now seems possible that a 20 percent rise in total national output may be achieved within 5 years. And the step-up will be even faster in such vital industries as steel, where capacity is now being increased by 6 percent per year, compared to normal growth of 2 percent.

This remarkable expansion may, of course, be interrupted. No one can foretell the possible effects of war. It is conceivable that much of industry would be destroyed in a death struggle with Russia. Or the strain of war might warp our social system in such a way as to leave no incentive for industrial expansion.

It is possible, too, that we may over-expand our defense industries and run into severe dislocations before we resume our normal development in peacetime lines. But economists are much less worried about this now than they were during World War II. The record shows that manufacturing industries expanded capacity 30 percent from 1939 to 1945. But from 1945 to 1950, capacity increased another 27 percent. In absolute terms, this was a bigger gain than during the war period.

So if we do not have a war, but a period of limited mobilization lasting perhaps 5 years, there is every reason to think that American industry will keep right on growing. Of course, certain industries will grow faster than others. And the leaders in growth will change, both during the mobilization period and in future years when more normal trends are resumed.

The Effect of Mobilization

If mobilization continues for several years, must we face increasing shortages? Or can our industrial plant be expanded to carry the extra burden of rearmament and gradually ease the pinch on our civilian economy?

This question is being widely argued among economists. The President's Council of Economic Advisers points out that it would be possible for national output to grow 25 percent in the next five years. Such a record has been made in the past under favorable circumstances. But other economists contend that a period of mobilization, involving considerable sacrifices but lacking the crisis atmosphere of a real war, is not one in which to expect great increases in productivity, which is the key to industrial growth.

Output per manhour – for the economy as a whole – did not increase noticeably during World War II. Among the reasons: Conversion to unfamiliar military products, shortages of skilled labor, and a lack of new tools for many purposes. The same factors stand today in the way of increasing productivity now.

On the favorable side of the growth question is this: Many industries, particularly those in critical defense activities, are planning substantial increases in capacity. These expansion plans as they are carried through, will result in a larger, more productive economy, particularly in the vital field of metals and metalworking.

Here is how the pattern of expansion for the mobilization period is shaping up:

The steel industry is increasing

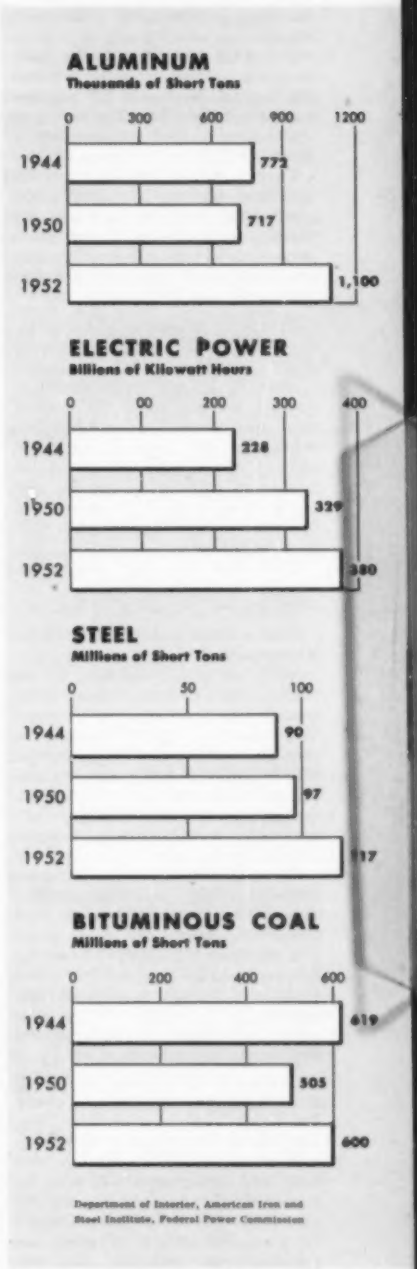


Fig. 1 — How our production goals in basic industries stack up with the peak achieved during World War II. In aircraft, the government is setting up facilities to produce 50,000 planes per year, compared with a 96,000 unit per year peak achieved in the years of World War II.

its capacity, from 104.2 million tons a year now to 117.5 million tons by the end of 1952. This will enable America to turn out more steel than the rest of the world all together turned out last year. The new goal will top peak steel requirements of World War II by 28 million tons.

There's also a big program for auxiliary facilities to supply the steel mills: railroad cars and ore boats, plants for refining low grade ores, coke ovens, and steel-making chemicals, such as oxygen and ferro-alloys.

Aluminum is another basic industry which is expanding under forced draft. Current plans call for upping capacity by 790 million pounds, more than 50 percent above the current total. And government agencies are calling for still more expansion to add as much as another billion pounds of capacity. (Actually part of this goal is likely to be realized by imports from Canada rather than by U. S. plants.)

Production of other nonferrous metals—copper, zinc, magnesium and titanium—will be pushed to the limit.

Metalworking industries—generally—are not likely to expand their capacity as rapidly as they did in World War II. Some types – those geared to key military programs – will expand rapidly. But overall the country now has more capacity for chewing up metal than for producing metal. To fill their defense orders, of course, metalworking industries will convert many of their present facilities.

Materials shortages will force progressive cutbacks in civilian production. Prospects are that auto and appliance makers will keep going at a relatively high level through the first part of 1950 by substituting less essential materials. In another year, however, there's likely to be little metal left over for non-essential civilian metal products.

Chemicals production is being stepped up to meet defense needs. Chlorine is one important item. Production of other heavy chemicals such as caustic soda, soda ash, sulfuric and nitric acid will also be increased. Production of organic chemicals has been bottle-necked by a limited supply of coke, the principal raw material. However, the industry is building rapidly the facilities to obtain these chemicals from oil and natural gas. Heading the list is benzene, vital for synthetic rubber and for many plastics, but the new flood of petro-chemicals will also include toluene, glycerine, ketones and aldehydes. More industrial alcohol will be made as a petroleum by-product, and by conversion of distilleries from whiskey making.

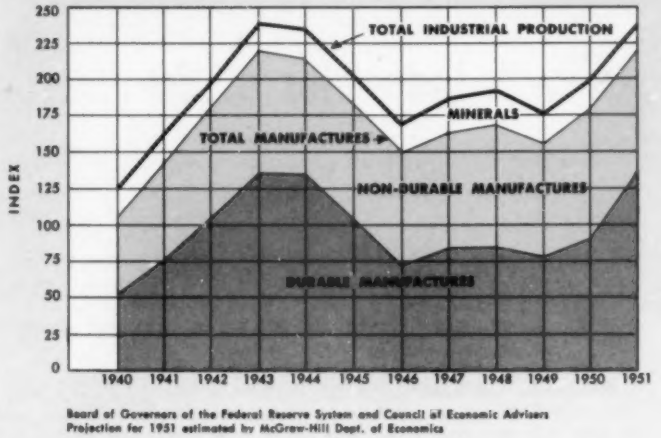


Fig. 2 — Index of industrial output based on a 1935-1939 average of 100 points. It now seems possible that a 20 percent increase over present levels may be achieved within 5 years. Of course, the growth in certain industries may be much greater.

Synthetic textiles will be one of the great gainers from mobilization because supplies of natural fibers – particularly wool—are falling far behind demand for them. Synthetics undersell wool and cotton now by large margins. One result: the rayon industry is planning to increase its capacity from 1.3 billion pounds now to 1.5 billion by late 1952. New plants are coming in to produce Orlon, Dynel, Fiber V, Nylon, Fiberglass and other synthetics.

Electric power is one key to greater production of metals, chemicals, almost all other industrial products. The industry is steadily boosting its capacity – at a rate of 9 percent a year. It plans to spend $3.2 billion for new facilities in 1951. In addition, countless industrial plants will be adding to their power-producing facilities.

Transportation industries will pick up a tremendous mobilization load. Steadily-rising business activity and shifts in industrial location – new East coast steel mills using South American ore, for example—add up to more traffic. Railroads will carry most of it. Their carloadings are already running 20 percent above a year ago. And the roads want delivery on 10,000 new freight cars a month to build up their fleet.

Truckers – with a fleet 70 percent larger than it was 10 years ago—will continue their rapid growth. Airlines, which already have priorities for building new planes, are likely to boom ahead.

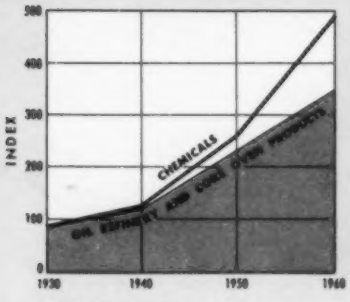
Other areas of the economy will be hit indirectly by mobilization. Manpower shortages are likely to be the biggest overall problem in construction, retail and wholesale trade, and the service industries. Contractors will shift the bulk of their workers to the $8 billion military construction program and essential civilian work, and sharply cut back homebuilding and commercial construction. The steady growth in trade and service industries will be temporarily reversed during this present period of mobilization.

Growth Industries of the Future

In the long run, industrial growth must be shaped to the pattern of a peacetime economy. Once the current emergency is over, the growth industries will be those whose products offer outstanding cost savings for business, or better living standards for consumers.

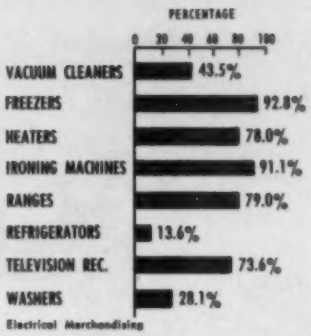
Industry, when the emergency ends, will have a three-way job to do. It will want, first, to keep its plants going to maintain something like full employment. It will rush to convert to meet the new wave of consumer demand – as it did in 1946. And it will want to replace and expand the equipment run down during the mobilization period, and to adapt products and processes developed during the emergency to peacetime uses.

This will increase the growth potentials of key industries:



Federal Reserve Board
Estimates for 1960: McGraw-Hill Dept. of Economics

Fig. 3 — Overall chemical production may increase 75 to 100 percent in the next ten years. Synthetic fibers, plastics and photochemicals are in for a big growth, but even the basic staples may grow a third or more.



Electrical Merchandising

Fig. 4 — The future electrical appliance market. Incredible though it seems, these were the number of wired homes without major appliances as of June 1, 1950. Long range, the appliance market is still high.

Chemicals seem to grow perpetually. Their production trend shoots upward as new discoveries broaden the range of chemical products. Overall, chemical production may well gain 75 to 100 percent over the next ten years. The individual lines with perhaps the brightest potentials are: synthetic fibers, plastic materials, petrochemicals, and drugs. But even the basic chemical staples show promise of gaining a third or more.

Metalworking. The possibility that the auto industry will continue to operate some assembly lines, at least through part of the mobilization period, rules out any precise estimates of future markets. But the steady rise in American living standards and in auto use make it likely that the industry will be operating in 1960 at something closer to its 1950 level – 8 million cars and trucks – than to 1940, when 4.5 million were produced. Prospects in other metalworking lines vary by products. Here are some highlights:

1. Electrical machinery production will expand rapidly. The utility industry expects its capacity to perhaps double in the next 10 years. This will throw a huge and sustained demand on the electrical manufacturing industry – for generating and transmission apparatus, as well as motors and other devices for industry and the home.

Industry will probably spend more than a dollar on its own power-service generating and using equipment for each dollar that the utilities spend on generating capacity. This includes, in addition to facilities for generating electricity and huge amounts of process steam, the equipment required to distribute and apply industrial power – notably for air conditioning, refrigeration, compressed air, and powering production machinery.

2. Office machinery that does everything, from solving simultaneous equations to registering bank transactions in a half-dozen currencies, will replace armies of pencil pushers as the 1950s go on. In the next 10 or 15 years, annual sales of office machinery may well double, could conceivably triple.

3. Farm machinery: U. S. agriculture is undergoing a revolution, still far from completed. It will take more than a decade of high level peacetime production to bring all U. S. commercial farms up to present first-class standards of mechanization.

4. Industrial machinery: Rising labor costs stimulate investment in all kinds of capital equipment – and there are vast opportunities for replacing old machines with new, more efficient ones. Some 43 percent of our machine tools are at least 10 years old, according to AMERICAN MACHINIST's latest inventory. And new machine tools are at least 40 percent more productive than those designed before World War II.

Mining industries, like metalworking, have widely varying growth prospects. Here are a few of the more dramatic possibilities: Sales of natural gas, by industry estimates, will double or triple within a decade. Mobilization – and shortages of steel – is likely to slow this growth only temporarily. Our total use of energy – for heat, light, power and transportation – has been expected to rise 20 percent by 1960. Mobilization is likely to push that schedule ahead – calling for rapid growth in petroleum, gas, and coal. Among the metals, aluminum, magnesium and titanium, will go ahead faster than the older metals. Titanium, still in the embryo stage, will also most certainly rank as a major metal by 1960.

Construction, despite its boom in 1948-50, has not yet caught up with the backlog of projects accumulated during the depression and World War II. The construction industry now has a backlog of more than $50 billion of heavy construction projects that have been proposed but not started. That backlog will grow during mobilization. By 1960 the construction industry may well be operating at a level 20 percent above its 1950 volume.

In consumer lines, growth potentials are hard to measure, since they depend so much on customers' fancies, and on the strength of merchandising efforts. But generalizations can be made about some of the important fields:

Food consumption is slowly rising, as farm production increases and nutritional standards become higher from year to year. At the present rate of population growth, and allowing for a 5 percent potential increase in per capita consumption, total demand for food may be up 15 percent by 1960, and the trade sees the strongest growth trend is in highly processed foods. All this will require greatly increased amounts of processing and packaging machinery and supplies, as well as equipment and supplies for the farmers.

Homefurnishings will enjoy a much greater market in the '50s than ever before. The recent housing boom has greatly increased the number of homes which are still in the "fixing up" stage. These new households can absorb a record volume of new furniture and appliances, whenever such furnishings become freely available.

Summing It Up

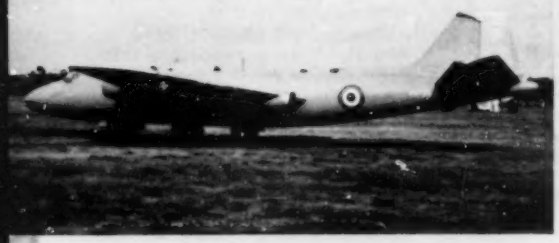
These industry discussions are not forecasts of business expansion. They are, rather, attempts to measure the possibilities for growth.

How fast the potentials will be realized – with the Russians dominating not only the outlook for the free nation, but the prospects for American business – only the future will tell.

In any case, the designer must be prepared, because a salient requirement is new and redesigned machines that will increase output.

Britain Leads in Jet Aircraft

Below — English Electric Canberra two engine jet bomber which is being considered for production in this country.



Design Activity:

Report from Abroad

The amount of design development — or lack of it — is one index of a country's strength or weakness. Here's a first hand report from McGraw-Hill World News correspondents in London, Paris, Rome, Brazil, Argentina, Australia, and Tokyo.

BRITAIN proceeding at peak level

LONDON — Design and development work is at peak levels in British machine-tool, aircraft, automobile, and electrical equipment makers, according to a sampling of representative firms by this correspondent.

Development activity would be greater if more men with a good broad grounding in fundamental engineering principles, blessed with common sense, and gifted with a flair for improvising new design solutions were available. Shortages of materials—especially metals—have not and are not expected to stop new development although they have caused delays in some companies.

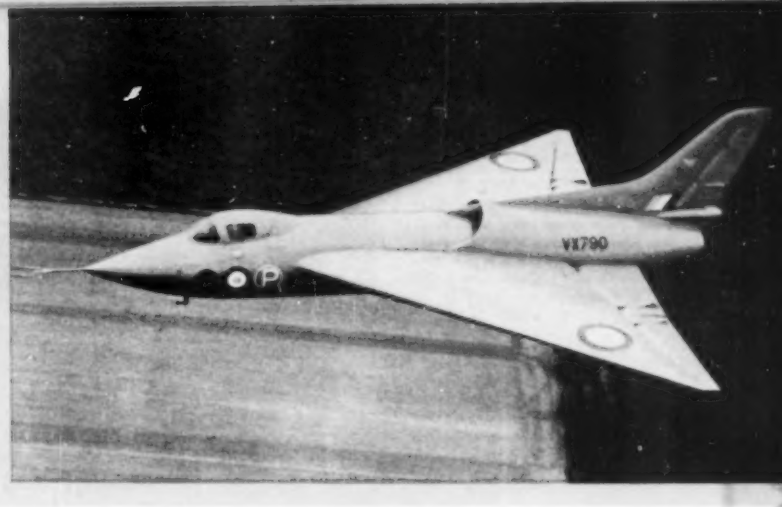
In machine tools, steady progress, rather than spectacular improvement, is the forecast. Marked developments are expected in auxiliary devices, such as for work loading and unloading; in the extended use of devices for speed-control to obtain maximum cutting speeds in using tungsten-carbide tools or the newer ceramic cutters; and so forth.

In automobiles, trend is in the direction of engines with greater cubic capacity, slower piston-travel but more power. Cars are tending to become heavier, to offset which aluminum is being used for body panels and in doors and hoods. A greater use of light alloy castings in transmission housings and cylinder heads can be expected for the same reason.

Austin is designing a new small car to meet the competition of the Morris Minor. Other manufacturers say they will continue to design their car around a seating capacity of six, comfortable for short distances, 3 to 5 miles. Rover will continue to develop its gas turbine car, which it sees as having possibilities as a high-speed motorcar for the sporting-man. Several orders already are booked.

In aircraft, the confident forecast is that gas-turbine engines will replace piston engines on all civil airliners except possibly the short-haul feeder lines, but that cruising speeds for civil aircraft are not likely to exceed 550 mph. in the next twenty years. Wings of pure-jet aircraft will be very thin, and swept-back; turbo-prop airliners, on the other hand, will probably look much as they do today.

Gas turbine aircraft engines, however, are likely to grow more and more complex, as the simplicity of the initial designs, with centrifugal compressors having a one-piece impeller, is left behind. Chief engineer Major Frank Halford of de Havilland predicts the gas turbine engines of the future will have axial-



Right — Avro 707B Flying Triangle. The opening in the fuselage is the intake for a Derwent jet engine. The cigar shaped cylinder at the base of the fin and rudder contains a small anti-spin parachute which can also be used to slow down the plane after landing.

Left—Westland Wyvern torpedo strike fighter which is powered by a 4,110 e.h.p. Armstrong Siddeley turbo prop engine. This plane will soon be going into service with the Royal Navy. Besides a heavy torpedo, it carries 18—90 lb. rocket projectiles.

flow compressors, with higher compression ratios and the turbo-prop types may possibly have their propellers running in ducts. Supersonic propellers may be developed, too, if a means of reducing the noise-level outside the aircraft can be found.

In many forms of machinery, *electronic controls* may be expected to be incorporated, during the next few years. Specific examples, which offer attractive possibilities, are: sectional-drives, which have to be closely integrated, as in steel-rolling mill equipment, paper-making, linoleum, rubber, cable-making, and particularly in printing presses (where the British know that they have to sprint to catch up with the Americans); measurements of thickness, surface finish, and humidity; drives such as those in knitting machines, where quick-change, quick-acceleration, and stepless variation are required; controls for passenger elevators, where smooth acceleration and deceleration, and accurate leveling of high-speed elevators, is called for. The British think they can do this more simply than the initial American methods. Other applications are hoists in mines, where speeds run much higher than many passenger-elevators, and where the productive efficiency of the mine is directly related to the hoisting cycle; wind-tunnels, both for the main fan drive and also for such delicate measurements as the air-flow's speed, possible now to accuracies within ¼ of 1 percent; and location-controls, as in a swing-bridge span.

Other *electronic equipment* likely to be significant in the future:

—TRANSDUCTORS (magnetic amplifiers) for controlling large amounts of a-c power with a small amount of d-c power. Rolling mill drives now incorporate large numbers of transducers.

—VOLTAGE-REGULATORS for accuracy of better than 3 percent and for high speed of response will be electronic in the future. This is not so much for power-generating stations as for power-consuming establishments, such as research and testing, particularly. Where voltage-control is required at the generating station, the preferred method recommended by Metropolitan-Vickers is to use an exciter whose field is controlled to regulate the field current of the main alternator.

—ELECTRONIC DIGITAL COMPUTERS are still only in the experimental stage in Britain, and may not be expected to be widely used in the near future. Other types of electronic computers, however, are in extensive use, and the Admiralty has developed this device for fire-control extensively, using the manufacturing resources of a number of firms.

FRANCE looks toward mass production

PARIS – Major new design trends only now are becoming discernible here as French industry begins to catch its breath after the War, the occupation, and the dizzy postwar inflation. Historically the French have been better at building prototypes than assembly lines. This has meant that many potentially useful French inventions have been left to gather dust in patent offices or have been manufactured abroad.

There are indications now that the emphasis has begun to shift from theory to practice; from experimentation to mass production. Several main influences are pushing French industry in this direction:

Firstly, there is a general realization that the War ruined France; that in the long run the country must now go to work to earn its own living again if it is to survive. Secondly, the technical missions to the United States sponsored by the ECA, of French industrialists and technicians, seem to be having quite an impact here.

Lastly, the sellers' market created by the post-Korean rearmament effort in the West has given a number of French industries new hope of making up for lost time; narrowing the price and quality gap between them and their foreign competitors; becoming competitive again in the world market. Quite a few French machine tool manufacturers, for example, who never were able to compete in the world market before have begun to export to the U. S. in small quantities and are doing a brisk business. The same holds true for many lines of chemicals, industrial glassware, and other industrial equipment.

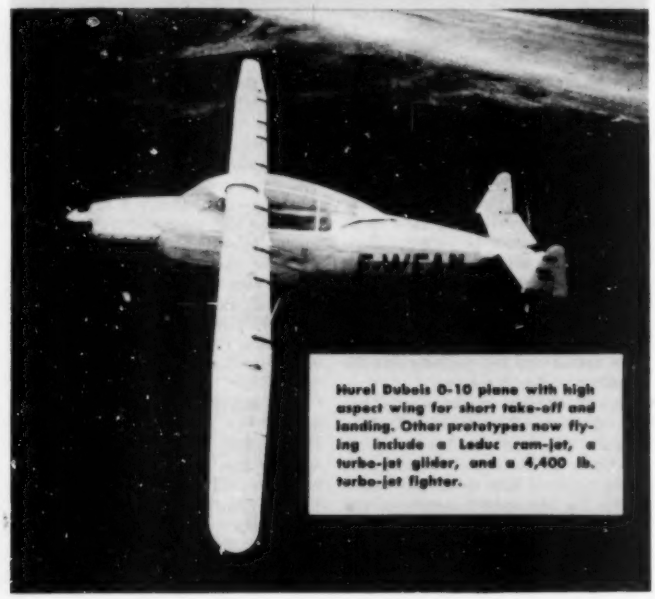
The success of the Schuman Plan and other projects for knocking down the nationalistic partitions within the European market certainly would tend to strengthen this trend toward simpler more practical designing.

There still are a lot of drags. The French market is limited not only by its absolute size but by the low level

French Designs

Right — Citroen's corrugated sheet light truck. Sheet steel appeals to the French because of its unpretentious appearance and low cost. Pre-stressed steels are also being used in car manufacture.

Below — Tiny 2 hp ultra economy car featuring front wheel suspension and a cylindrical body that makes a chassis unnecessary. This is a pre-war model that is still in production.



Hurel Dubois O-10 plane with high aspect wing for short take-off and landing. Other prototypes now flying include a Leduc ram-jet, a turbo-jet glider, and a 4,400 lb. turbo-jet fighter.

of national productivity – roughly one-fourth that of the U. S. – which holds down purchasing power proportionately. Between 70 and 80 percent of the average French family budget is now spent on food. That doesn't leave much over for industrial consumer goods.

The fact that the French market has been contracting rather than expanding for decades has led to intensive cartelization of French industry. The resulting lack of competition has had an enervating effect on the development of new products.

The chronic shortage of capital has also acted as a brake upon research and development of new processes and designs, as has inflation which has assured easy sales and easy profits without much competition.

Finally, the quality of many French raw materials–notably steels –is spotty and they frequently are insufficiently standardized; liaison is traditionally weak between the technical and commercial departments of French firms.

In automobiles, the trend is toward ultra-utility and ultra-economy vehicles. Citroen best exemplifies this with its tiny two horsepower model made of light, partly corrugated sheet steel, and its square corrugated sheet-steel light trucks. The use of corrugated sheet for economy vehicles seems definitely to have appealed to the French because it gives such an unpretentious appearance–and it's cheap. And also for cheapness, there is no automatic transmissions nor much chrome, copper and other scarce metals.

Further to achieve economies, Re-

nault, for example, has developed considerably the use of "prestressed" steels, precision casting using wax molds for manufacturing such things as valve seats, valves, pump pinions and so forth. Finally, the company has pushed development of leaded carbon steels.

In airplanes, the French are lagging badly design-wise. But they are working on four prototypes which could influence the evolution of aviation. The first is the Leduc ram-jet which many French aeronautical engineers believe will be the fighter and maybe even the transport plane of the future. The first prototype has been flying for nearly two years now and two others are nearing completion.

The second interesting prototype is the French axial flow turbo-jet ATAR 101 made by the Societe Nationale d'etude et de Construction de Moteurs d'Aviation. This has a seven stage compressor, a single turbine, and an annular air chamber; is an improvement of the German BMW-003. It has a rated static thrust of 4,400 lb at 7,500 rpm. The French air force may order it for mass production.

Thirdly, the French have developed a prototype called the Hurel Dubois 0-10 which has an ultra-high aspect wing permitting it to land and take off in about 500 ft. French airmen have high hopes of developing a series of extremely flexible military transports, troop carriers, and reconnaissance planes from this basic design.

Lastly, the little Fouga "Cyclone" glider powered by an 80 lb turbo-jet, and which has a ceiling of 40,000 ft may open new avenues of private sport flying, and may be used for military reconnaissance.

There is quite a lot of interest being shown in opposed piston diesel engines. The Manufactures d'Armes de Paris has developed and put into mass production a particularly sturdy and economical line of these engines.

In the textile machinery field, three different prototypes of circular looms have been built here and are reported to be living up to expectations after extensive testing. None is ready for mass production.

France is the only nation on the Continent which possesses an atomic pile. It is planning to build a larger atomic research center soon near Versailles. Since these are too small to be used for production of bombs they are devoted entirely to exploring possible peaceful uses of atomic energy and radioactive isotopes.

New Italian Typewriters

Lettera 22 portable typewriter. Well built, sleek, and streamlined with features comparable to machines produced in other countries.

Lexikon electric typewriter, produced by Olivetti, was introduced last year. Design in Italy is hampered by lack of funds, lack of markets, and unsettled political conditions.

ITALY making progress — But slowly

Three main factors are seriously affecting the whole engineering industry:

(1) Scarcity of capital.

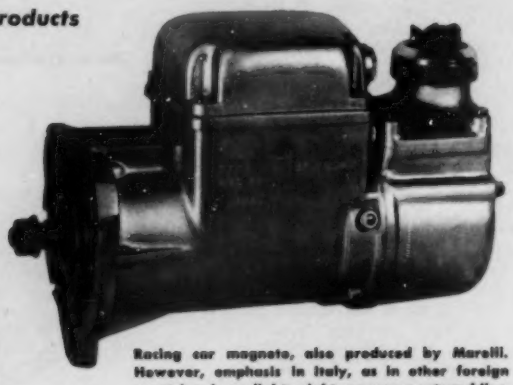
(2) Unsettled political conditions at home and abroad.

(3) Market conditions.

Lack of Capital: Industrial giants like Isotta-Fraschini, Caproni, Breda and Alfa-Romeo are limping along on part-time work. Of the former large aircraft engine works, only Alfa-Romeo continues to turn out motors. Most others stopped as far back as 1943. Ing. Filippo Zappata, of the Aviation Section of one of Milan's largest industrial concerns, the Breda Corp., designed a 4-motor commercial transport, but the company lacked sufficient funds to pro-

Other New Italian Products

Marelli 500 w dynamo for heavy trucks. Production of automobiles was at an all time high last year, largely because of the good showing of Fiat.



Racing car magneto, also produced by Marelli. However, emphasis in Italy, as in other foreign countries, is on lightweight, economy automobiles.

duce it, even with a definite order on hand. No Government assistance was forthcoming.

Lack of Markets: Pre-war, one-third of the engineering industry's production was accounted for by State orders. During the war three-quarters of the stepped-up output was solely for war purposes. Today, Government orders play a relatively minor role, and its refusal to devalue the lire has cut off many potential export markets.

Italian aeronautics which led the jet propulsion field with the Camproni Campini experimental aircraft of 1941, are now straining to catch up on the lead of other nations by building foreign aircraft and engines, and by gradually developing their own designs – the Gabrelli 80 jet trainer project of the Fiat Company.

The Fiat Works have been largely responsible for the all-time production high of automobiles in 1950. Fiat engineers, working in first-class surroundings, have already put into mass production a new auto with the traditional European economic-to-run motor but with an American-type body. They pay unstinted praise to ECA supplied machine tools.

Magneti Marelli claim to have replanned and improved almost all their automobile and motorcycle electrical equipment since the end of the war; aided by extensive, up-to-date laboratories, and many years' experience; they also pay tribute to the latest equipment and machinery imported from the U.S.A.

Olivetti typewriters and Necchi sewing machines have gained large, new export markets with their mass-produced perfection. Motor scooters have been put on to an apparently insatiable home market at a reasonable price in ever-increasing numbers—one manufacturer was turning out war-time airplane motors.

ECA officials blame Italian industrial ills on World War II but add "Long-term prospects are good since Italy has excellent engineers, an abundance of skilled workers and products of high quality and virtually perfect design."

With foreign markets for products currently very good, perhaps manufacturers will move ahead much faster than is anticipated at the present time.

BRAZIL shines in civil engineering – Not mechanical

RIO DE JANEIRO—With few exceptions, there is little original product design carried on in Brazil – this country being far from "industrialized" as the word is used in the U.S. Following is a brief summary of various industries:

Construction machinery—Nothing at all except mule-drawn dumpers to be found. Everything imported.

Shipbuilding equipment – None. Nor any shipbuilding either.

Aircraft engines—None.

Aircraft frames and parts – One little plant makes modified "Cubs" in very small quantities (Air Force is using U. S. Pipers).

Textile machinery—No automatic machinery made in Brazil, all imported.

Packaging machinery – All imported.

Automobiles—No manufacture. All assembly of imported units, with only some few bus and truck bodies made here for imported chassis.

Machine tools – One moderately major plant, manufacturing only standard tools, and nobody buys them except under compulsion of import regulations.

Railroad equipment—Some freight cars, flatcars, cattle cars. Locomotive, control equipment all imported, likewise coaches.

Household appliances—There is a fair range of household appliances like toasters, electric coffee pots, etc., but nothing which is anything but ersatz.

Food processing equipment – All imported.

Communications equipment—Make maybe 250,000 units a year, all on designs and using parts supplied from abroad to a large degree.

Agricultural machinery – Make plows, harrows and the like, but large, heavy and involved stuff is all imported.

You naturally would ask: "What do they make in Brazil?" The answer seems to be consumer goods of light nature, using virtually 100 percent imported capital goods, plus a wide range of heavy consumer goods made in arrangement with foreign firms under license—with the designs and specifications supplied from overseas. Where Brazil really shines is in the field of civil engineering.

ARGENTINA busy training talent

BUENOS AIRES—Argentina is so busy trying to absorb imported skills that it has been unable to make any appreciable contribution to original design. Weeks of checking of prospective sources have failed to unearth any single lead to a product or a process which might be defined as "creative."

Argentine refrigerators are adaptations—copies of American and British designs; the better ones use imported motors. Typewriter production has gotten under way—but the fifteen machines turned out each day are European from start to cover. Autocar, this country's only domestic automobile, is a hand-built Cisitalia, with Italians forming the cadre of the personnel. Molded plastics toys or dishes are last year's Woolworth models in copy. In short, Argentina has yet to develop the engineering skill necessary for original design. Ten years from now, the story may be different.

JAPAN: The price is low

TOKYO—Japanese design trends run almost exclusively to copying American designs—and even this activity is limited. The majority of Japanese manufacturers are trying to pass off on the world the products which they have always made.

Even where foreign purchasers issue tenders with precise product specifications, Japanese manufacturers ignore those details that are at variance with their normal product. The Japanese want to make the product just as they have always made it, and the buyer can take it or leave it.

Design and product development is held back by several factors. One is a shortage of capital funds. Most companies are living from hand to mouth even having difficulty meeting payrolls on time. Short-term interest rates are very high; long term industrial loans aren't attractive to the investors or the banks.

Other drawbacks are lack of good materials; of skilled design engineers; of an understanding of the competitive problems in world markets. Some companies have tried to develop steels and alloys comparable with American and European quality, but Japanese industry for the most part uses cheap non-standard materials if at all possible. Engineers are paid on the average only slightly more than common laborers. Seldom are they rewarded for new developments.

Japanese export products up until World War II consisted of textiles (over 60 percent), cheap pots and pans, and other low grade consumer products. Heavy industry was geared to supplying the home market and the colonies. The colonies couldn't shop around but had to take whatever was supplied from the home islands.

In consumer manufacturing, price was the paramount objective. Textile engineers, for example, developed the world famous Toyoda automatic loom, to reduce cotton weaving costs. The same philosophy is applied to the producer goods field, but with a slight variation. Manufacturers believe that it doesn't make any difference whether the quality is inferior to that of western makers; they will still get the business because they will offer price savings of as much as 50 percent.

There are, of course, some exceptions to the normal low level of design and product development control in Japanese industry. The Nippon Optical Company, for example, is producing what some LIFE photographers consider the world's best 35 mm camera. It combines the best features of the Contax and Leica, and optically is superior to the models of the Germans. The Nikon camera with the Nikkor lens is manufactured with some of the tradition of the old Japanese craftsmen who produced lacquerware which has lasted for over 1,000 years. There is a constant excellent quality, with no variation between cameras.

An interesting new company is the Chemical Plant Consultants Company, established to carry out development and research work on chemical machinery. Among its clients are the principal makers including Mitsubishi Chemical Machinery Company, Hitachi Ltd. Ishikawajima Heavy Industry Company and Kobe Steel Company.

This, however, is the great exception, although one of Japan's greatest needs. The machinery branch of the Ministry of International Trade and Industry recently completed a survey which found that Japan within three years will be unable to compete technically in any way, even price, with western manufacturers in its Asian markets. Most Japanese business leaders refuse to take warning from such reports.

In the worst shape of all is the machine tool industry. There was some hope right after World War II that this industry might have a bright future. Fewer units are being manufactured now than in any year since before 1933. Quality is depressed, and the machine tool makers see little hope for improvement without importation of foreign technology and designs. Their own designers are either way behind or have moved to other industries.

AUSTRALIA hindered by small markets

MELBOURNE—For at least a decade ahead industrial design in Australia will be dominated by foreign practice. Even so, Australian design efforts will be limited to a relatively unimportant sector of the mechanical, electrical and chemical industries. Most equipment will continue to be manufactured to foreign blueprints, with minor modifications to meet production conditions.

These modifications are necessary to avoid excessive capital outlays for heavy presses, expensive dies and other mass-production equipment. Its capital cost would have to be spread over a larger number of units than can be produced for the small Australian market.

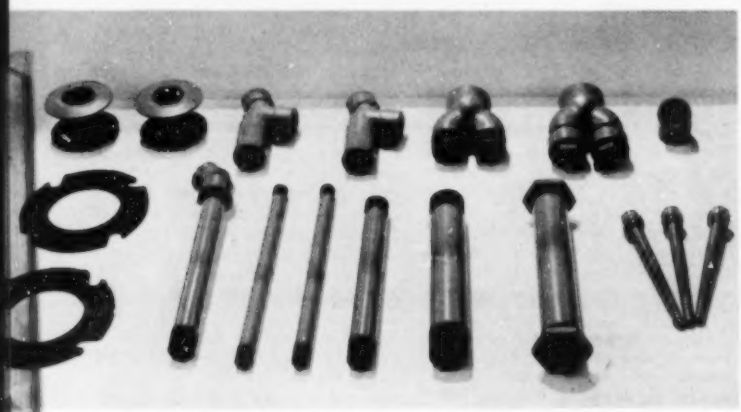
Hence the trend is to redesign components so that they can be produced by gray iron casting, welding, oxy-acetylene cutting and other methods that require a relatively high input of labor but a correspondingly lower input of capital.

Australian industry will continue to assimilate proven product engineering practices of all major industrial nations. A marked preference for American designs has developed since the Second World War, with some significant exceptions:

Gas turbines, Diesel and oil engines, merchant ships and naval vessels and, partly, military and civil aircraft follows British design practice. Textile machinery is largely of British, German, Swiss and French designs. Machinery for strip-mining of coal and Diesel pumps are based on German designs. There is no indication that these preferences will change in the next few years.

Specialization, Large Size Are Trends in Plastics

The history of plastics development parallels ferrous metals development, but at an accelerated pace. First, there were one or two basic plastic materials – cellulose nitrate ("celluloid") and phenol formaldehyde ("Bakelite"). Then came the transparent acrylic plastics. These were rapidly followed by modifications, and finally a host of new materials and forms: Ureas, melamines, vinyls, polystyrene, nylon, polyethylene, polyesters, fluorine plastics, reinforced and honeycomb materials.



Extruded products made of blend of high styrene resin and acrylonitrile rubber: (center) chemically resistant pipe and fittings; (far right) cathode strip used in electroplating and textile bobbins; (far left) foreground, cams for air hose reels and background, wire spools. Properties of these materials shown below. U. S. Rubber Company

These developments took place so rapidly before, during and after World War II that engineering evaluation of the newer materials has not yet been completed. But in the midst of this evaluation, two important new trends have become evident: Use of "blends" of plastics and plastics with synthetic rubbers, and molding of parts of increasingly greater size and weight.

Rubber-Plastics Blends*

New types of plastics with characteristics not before found in any material are the result of rubber-plastics "blending." Natural rubber is a relatively soft material, unless it has been heavily reinforced with minerals or other pigments, or unless it has been fully "cross-linked" as it is in hard rubber. There is no continuous gradation of hardness in rubber itself. On the other hand, the synthetic resins – styrene, phenolics, vinyl chloride–usually in themselves are hard and are made soft and flexible only by the addition of plasticizers. It is now possible to tailor the softer ingredient and the harder ingredient to each other so that they are mutually compatible. As a result we have a whole series of relatively new plastics which are rigid or semi-rigid or flexible, of extreme toughness, yet easily formed into products.

At their present stage of development, these materials can be grouped

*This section based on information and data furnished by the United States Rubber Co.

Properties of New Plastic-Synthetic Rubber Materials

Properties	Thermoplastic-Elastomeric Blends		Thermosetting Phenolic-Nitrile Rubber (Typical Compound*)
	Injection Molded and Extruded Forms	Sheet Form	
Specific Gravity	1.05-1.08	1.06-1.23	1.35
Tensile Strength, psi	4,000-5,300	4,000-9,400	4,000
Flexural Modulus of Elasticity, psi	160,-290,000	200,000-210,000	100,000
Izod Impact, ft-lb per in. notch	0.63-10.0	3.0-9.0	1.3
Hardness, Rockwell	R 87-R 110	R 90-R 120	Shore "D" 70
Flexural Strength, psi	5,000-10,000	6,500-14,000	
Thermal Conductivity Btu/hr/sq ft/F/in.	1.0	1.0-1.30	
Heat Distortion (264 psi), F	155-175	153-160	
Dielectric Strength, volts/mil	300	385-390	400
Dielectric Constant			
60 cycles	4.7	3.73-5.47	9
10^6 cycles	4.3	3.56-5.28	
Power Factor			
60 cycles	0.02	0.0121-0.0417	0.20
10^6 cycles	0.015	0.0110-0.0183	
Water Absorption, 24 hr. room temp., %	0.26	0.35-0.4	0.3

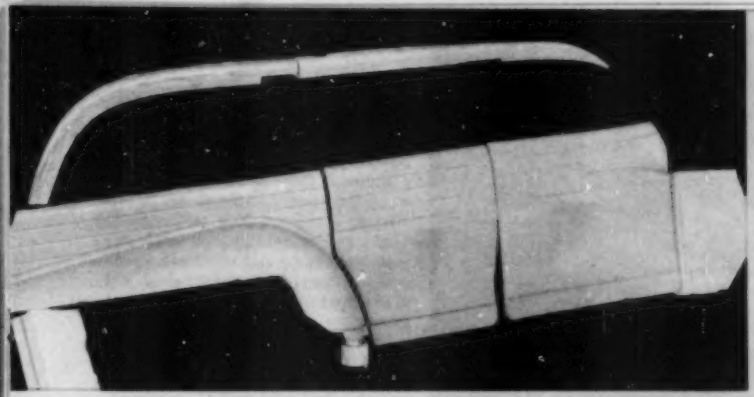
*Compounds with higher strength values are produced by varying amount and type of fillers, and proportion of main constituents.

Impact Strength of Various Plastic Materials

Material	Izod Impact (ft-lb per in. notch at 77 F)
Thermoplastic-Rubber Blends	3.0-11.0*
Rubber-Phenolics	0.60-2.30**
Molded (Conventional) Phenolics	0.36-1.30
Acrylic Plastics	0.4-0.5
Polystyrene	0.25-0.40
Cellulose Acetate	0.4-5.2
Cellulose Acetate Butyrate	0.6-5.4
Urea-Formaldehyde Molding Compounds	0.25-0.35
Cast Phenolic Resins	0.25-0.40

*Specific value depends on relative percentage of each plastic and elastomeric (rubber-like polymer) ingredient.

**Specific value depends largely on amount and type of filler used. This applies also to other (conventional) thermosetting molding compounds.



Potential use of fabricated sheet form of thermoplastic-rubber blends in automotive design. Station wagon roof rail at top illustrates use of grain transfer to sheet, which is heated and formed on a male cast aluminum form mounted on tables; presses are used. Both front and rear sections have a considerable undercut but the flexibility of the material permits it to be snapped off the mold. The door panels and rear quarter do not represent any adopted design. These parts represent considerable fabrication time when present materials are used. The entire assembly could be produced with these new materials in one draw over a male mold. U. S. Rubber Company

Projector case made of thermoplastic-rubber sheet material exhibits excellent design and fabrication. U. S. Rubber Company

into two general types: (1) copolymers of styrene and butadiene, copolymers of styrene and acrylonitrile, and tripolymers these with vinyl resins—all of these are thermoplastics; and (2) mixtures of nitrile rubber (Buna N) with phenolic resins—these can be considered as thermosetting materials.

THERMOPLASTIC-ELASTOMERIC BLENDS. The first group, the thermoplastics, seem capable of almost infinite variation in properties and form. It is produced as two series of materials: (a) A compound for injection and extrusion molding of machine parts and such products as electrical terminal blocks, dials, telephones receivers and bases, plugs, switches, and a wide variety of extruded parts; and (b) as sheets, which can be formed in compression presses into housings, battery cases, television masks, typewriter cases and similar parts. Both series are made from essentially the same materials, but modifications in formulation adapt each for its particular form.

The molding and extrusion formulations are produced in a wide range of properties, as shown in the accompanying chart. However, these materials are outstanding in their ability to be both hard and tough at the same time. In addition they are chemically resistant and are used in industrial equipment requiring simultaneous maximization of these properties. Such products are cathode edge strips, chemical pipe, textile end caps, quills and bobbins. Small mechanical items such as cams, gears and cable floats are ideal applications. In such applications they replace wood and many metals.

Molding conditions vary somewhat for each machine and mold. However, as a general starting point following injection molding conditions, in an 8 oz machine at 75-100 percent of capacity, can be used: Cylinder temperature, 400-450 F; mold temperature, 130-150 F; cycle, 30-40 sec; pressure, 20,000 psi; gate and sprue size, as large as feasible. Excellent finish extrusions can be made with somewhat harder formulations, using 425 F die and 400-450 F cylinder temperatures. For compression molding, both hard and soft formulations can be used, with 300-325 F molding temperature, and 1,000 psi pressure. General fabricating and finishing methods, including machining and polishing, can be used with these materials.

Another form of these plastic-elastomeric blends is "tailored" specifically to be made into rigid pipe characterized by very high impact strength, for use in handling many corrosive industrial chemicals. It can be threaded with standard hand or machine tools. Being thermoplastic, it can be bent by heating to 180-185 F in a water bath or hot air oven. Although somewhat more expensive, this material will replace hard rubber and other thermoplastic pipe where its excellent properties are required: Linear thermal expansion, 0.000034 in./in./F (0.000061 in./in./C); good toughness down to 20 F; specific gravity, 1.04; and excellent resistance to strong alkalies, mineral acids (10-25 percent concentrations) and their common salts. They are available in 0.55 to 1.94 in. ID, 0.84 to 2.38 in. OD, and can be used at 100-150 psi (70 F) working pressures.

The sheet-forming modification appears quite promising for relatively large, structural applications. This form is produced by calendering rolls of the material which is cut into sheets, laid up to the desired thickness and then pressed together by applying heat and pressure, forming a homogeneous mass. The pressed sheets can be produced in thicknesses from 0.031 to 1.00 in., and in sheet sizes up to 50 x 84 in. Standard grain finishes and a smooth glossy finish can be applied. This material can be formed into intricate shapes with relatively light and inexpensive equipment, using wood, Masonite, aluminum or Kirksite molds. Forming techniques include straight vacuum with female cavity, male and female with mechanical pressure, plug (male or female) and draw ring, plug and diaphragm. In all techniques a warm mold (90 to 125 F) is used; the material is heated to 280-300 F before forming. Decorative designs or trade marks can be hot embossed in the surface.

Basic properties of the sheet form include: Exceptionally high impact strength at normal temperatures; relatively low specific gravity; resistance to attack by a wide range of chemicals; good dielectric properties; and low thermal conductivity, indi-

Large size and accurate reproduction of detail are achieved in this 19 in. RCA television mask injection molded of styrene plastics. More than just a "picture frame," the mask serves as an insulator against the 15,000 volt potential carried by the metal tube. It also serves as a tube support, and eliminates special fastening methods while set is being shipped. Styrene resists the action of ozone formed in operation of tube.

Radio Corporation of America and Mack Molding Company

cating possible application in the refrigeration field. Physical and electrical properties are shown in the accompanying table. The rigid form is supplied as the standard grade. However, for special applications it can also be furnished in a softer grade (having considerably increased impact strength, particularly at lower temperatures), in a special electrical grade, and also in a flame-resistant grade.

Sheets and shapes can be machined with ordinary wood and metalworking equipment. They can be sawed, sheared, drilled, punched, riveted, sanded, cemented, and polished.

THERMOSETTING PLASTIC-RUBBER MATERIALS. Developed to bridge the gap between soft rubber and hard rubbers, a series of phenolic resin-nitrile rubber mixtures will fulfill the need for high impact materials that are resistant to abrasion and chemicals. They can be produced in varying degrees of flexibility, and are available as a molding compound, and in the form of sheets, rods, tubes and gear blanks.

One of its outstanding uses is for the manufacture of high strength, low-cost gears to replace metal gears in such applications as heavy-duty

New Materials and Continuing Developments

Exthoxyline Resins

These resins are a new generic series, formed by chemical "condensation" of poly-arylethylene oxide compounds with acid anhydrides, amines, and other compounds. Like the polyesters, they form thermosetting compounds without evolution of water or volatiles. They are produced in three basic commercial forms: Bonding resins, casting resins and surface coating resins. The bonding resins require only low pressure, and are effective with glass, ceramics and metals. Like the polyesters, they have good dielectric properties, and are used in electrical castings—"pottings."

Fluorine Plastics

Two polymers in this group have firmly established themselves as packing, seal and insulation materials of outstanding resistance to corrosive chemicals, temperature extremes and electrical forces. These materials, polymers of tetrafluoroethylene and monochlortrifluoroethylene, are marketed under the tradenames of Teflon (DuPont Company) and Kel-F (M. W. Kellogg Company). They will fill a need in the following applications:

Radio and Radar: Coaxial cable, connector and other electrical insulation, where low loss of high frequency energy is required. Other materials, such as polyethylene, have satisfactory electrical properties, but above 100 C they are not sufficiently stable.

Seals: Static-resistant, and resistant to strong acids (such as fuming-nitric), hydraulic fluids, fuels, and engine oils from -65 to 400 Fahrenheit.

Hose: To carry aircraft hydraulic and engine oils from -65 to 400 Fahrenheit.

Present limitations include poor cold flow and permanent set characteristics, but these are being improved, both by modifications of present polymers and development of new fluorine plastics.

Cellulosic Plastics

Although cellulose acetate has been supplanted in some applications by less expensive thermoplastics, it will continue to hold its own in many electrical and consumer products. Two developments are worthy of note: (1) Flame-resistant acetate, used in such applications as housings for small-motored electrical appliances; and (2) high-acetyl acetate. Compared with the older type, it has far greater dimensional stability in the harder flows.

Ethyl cellulose has a good future because of increasing toughness that will be required of thermoplastics, over a wide temperature range. Its impact strength is greater than that of any other thermoplastic material, with the possible exception of the new plastic-rubber blends (pp 154-155). Textile bobbins and flashlight housings are typical applications.

lathes, household appliances, plating barrels, automotive timing devices and dynamometers. Gears made of the new plastic have been operating for more than a year in applications where conventional metal gears have failed within a few weeks. These gears were molded in one piece to very close tolerances, eliminating the need for elaborate finishing operations.

The material is also suited for washing machine parts where its resistance to the newer type of synthetic detergents has given it an advantage over metal. Other promising applications include: Fuel pump parts, battery cases, valve seats, plating barrels, bearings, electrical insulators, and various automotive parts.

These materials are light in weight and extremely stable at high temperatures. They have good resistance to fire and its high dielectric strength makes it a good electrical insulator. Their impact strength is superior to most plastics now available and they can be molded economically in complicated shapes by either compression or transfer methods. Complete details can be found in the article "Rubber-Phenolic Materials for Greater Impact Strength" PRODUCT ENGINEERING, January, 1951.

Large Molded Parts*

Improvements in properties of thermoplastics, especially styrene plastics, have led to molding of parts with increasingly large projected areas. This trend will continue with improvement of dimensional stability in the presence of heat, moisture and loads, as well as "zero stress" dimensional stability. Large thermoplastic parts can be molded for refrigerators, housings, camera cases, table radio cabinets, automotive, electrical and lighting parts.

Impact and heat resistance of styrene plastics continue to be improved. Some of the new materials are blends of the styrene-acrylonitrile type; others achieve their improved properties by tricks in the polymyerization processs.

Refrigerators offer a good example of increasing use of styrene plastics in large parts. In one of the 1948 Crosley models, a total of 18.28 lb of plastics were used—5.54% of total refrigerator weight – with styrene a little less than half of the total plastics. In a comparable 1950 Crosley model, which utilizes 58 different plastic parts, 24.135 lb of plastics are used, of which 17.546 lb are styrene.

*This section based on information supplied by Plastics Division, Monsanto Chemical Co.

Plastics have replaced glass and porcelain enameled steel for such parts as meat storage trays, breaker strips and freezer doors.

With the advent of injection molding machines capable of handling 300-oz (already in use) and 400-oz shots, projected area and weight of molded parts are rapidly increasing. Lenses for 19 in. television sets, 11-lb battery cases, and ice cream cabinet lies up to 5500 sq. in. projected areas are existing examples. Projected areas of over 1,000 sq. in. are possibilities for the immediate future; one refrigerator manufacturer plans to mold the entire bottom bin of styrene. Experiments are being made with short glass fibers which can be injection molded as a reinforcement with styrene plastics. If this is successful, molding of large flat areas is planned; an example is a refrigerator inner door panel, now made of thermosetting plastic laminates.

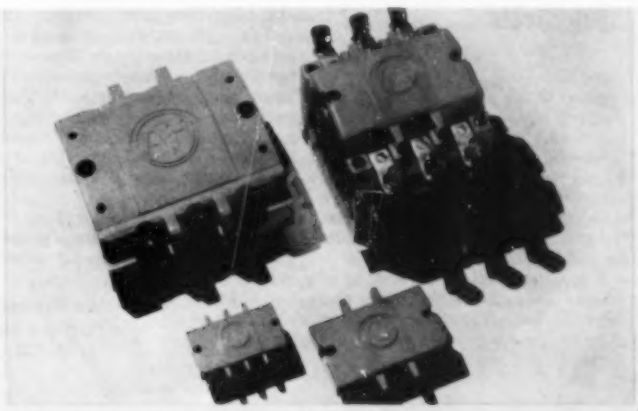
In the thermosetting field, the future for large phenolic moldings looks promising. The Admiral 40-lb console television cabinet is a good example of good design in large phenolic moldings. However, informed opinion is that parts larger than this cabinet, requiring properties of thermosetting plastics, should be made of reinforced plastics.

Nylon

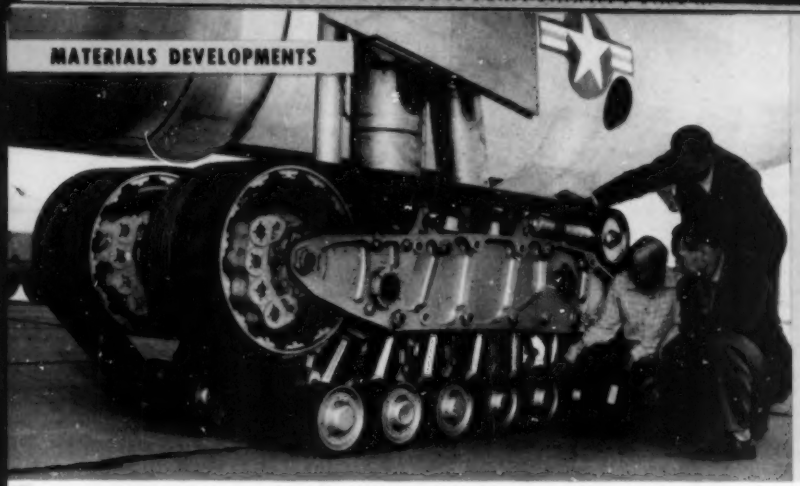
This is rapidly becoming the preferred bearing material in certain types of machines, where little or no lubrication is available: Textile machinery, kitchen appliances, calculating machines. For small gears, too, it is replacing metals.

Reinforced Plastics

This is perhaps the most significant field in plastics as far as future developments are concerned. This group of materials was completely described in the 24-page article by Richard J. Francis, which appeared in the February 1951 issue of PRODUCT ENGINEERING. Two specific developments worth watching (1) Plastic-fibrous glass gear covers having only a fraction of the weight of steel, with greatly reduced sound and vibration transmission; and (2) Plastic-fibrous glass pipe, with phenomenally high bursting strength. Cost of materials is higher than ferrous metals, but greatly reduced weight and increased resistance to corrosion will offset this factor.



Alkyd molding materials — Formerly used only as ingredients for organic coatings, alkyd resins are now available in a thermosetting compound with excellent electrical and heat-resistant properties. It can be molded at low pressures, allowing greatly increased speed of molding. In this line of magnetic motor starters for 220-volt, three-phase circuits ranging in maximum capacity from 25 to 200 amp, size reduction, with increased efficiency, and durability, is made possible by the alkyd moldings. Each starter uses two molded parts, the base (combining functions of the terminal block) and the hood. The plastic block is the only insulator between terminals; its lower part serves as a base for the contacts. Pinchen Division, Libbey-Owens-Ford Glass Co.



Use of high strength alloy steel made design of this experimental B-36 track-type or "caterpillar" landing gear possible. The complete landing gear contains 36 parts made from an alloy steel that can be heat treated to extremely high tensile and impact strengths. Track on the main landing gear shown is designed for a maximum average of 57 psi pressure on the landing strip, as compared to a pressure of 156 psi exerted by the conventional wheel type gear on a B-36 of the same weight. Nose gear is similar.

Consolidated Vultee Aircraft Corp. and Crucible Steel Company of America

Advances in Metals

Future developments will produce metals and alloys with higher strengths and better resistance to creep, fatigue, oxidation, and corrosion. Improvements are expected in stainless and alloy steels, in the lightweight metals, aluminum and magnesium and their alloys, in currently available "super alloys" and in protective coatings for high-temperature service and corrosion resistance.

Alloy Steels*

The trend in steel is definitely toward increasing use of the alloys, as opposed to the plain carbons. This is partly a result of realization of the significance and importance of the hardenability concept, which came during the war. The familiar NE (National Emergency) steels were developed by retaining adequate hardenability as the prime requisite for most applications.

A parallel trend is the seeking of greater strength-weight ratios and corrosion resistance than possible in plain carbon steels. The answer has come: Low alloy steels which give decidedly improved properties over common structural steels, especially in increased yield point.

Several proprietary low-alloy high-strength steels, although not having the same chemical composition, possess common physical and mechanical characteristics. The guaranteed minimum yield point is generally 50,000 psi in sections ½ in. thick and less, diminishing somewhat as thickness increases up to two inches. The ultimate strength is appreciably higher. These steels can be cold formed in bending, flanging and mild drawing operations. They are readily weldable and do not become hard or brittle when cooling from the welding heat. They have from four to six times the atmospheric corrosion resistance of plain steel, or two to three times that of copper steel. Since the allowable fiber stress is 50 percent greater than for structura' carbon steel, a properly designed low-alloy steel beam section with only two-thirds as great section modulus will have equal carrying capacity. This eliminates deadweight, and more than offsets the initial price differential between low alloy and plain carbon steels.

A new series of low carbon, low "multiple" alloy steels has just been developed (see properties in accompanying table) which have even higher strength levels than earlier low alloy types. Unlike earlier types, however, which are furnished untreated, these steels are usually furnished heat treated. The material is primarily intended for use in plate form, but where subsequent forging or hot forming is required, it can be obtained untreated, and then later heat treated before being placed into service. Its toughness is outstanding, even at low temperatures, when compared with ordinary welding-grade steels. Other properties such as resistance to atmospheric corrosion, are about equal to those of the established low alloy types. An immediate application is for heavy duty power shovels, for which requirements of strength, rigidity and lightness are particularly high.

In response to the demand for steels of even higher strengths, new materials with larger percentages of alloying elements, but still in the "low" (less than 5 percent) range, are being developed. These are marketed in an untreated condition,

*This section based on information supplied by the United States Steel Corporation and Crucible Steel Company of America.

Mechanical Properties of a Heat-Treated Multiple Low Alloy Steel*

PROPERTY	SECTION THICKNESS, IN.		
	¼ to 2 incl.	Over 2 to 4 incl.	Over 4 to 6 incl.
Yield Strength, 0.2% offset (min), psi	100,000	90,000	90,000
Tensile Strength (min), psi	115,000	105,000	105,000
Elongation in 2 in., % (min)	18	17	16
Reduction of Area, % (min)	55	50	45
Cold Bend, 180 deg	¼ to ½ incl.	Over ½ to 1 incl.	Over 1 to 2 incl.
	1 T	2 T	3 T

* Carilloy T-1 (United States Steel)

Aluminum car bodies coming? Buick's experimental convertible, with a 300 hp supercharged V-8 engine capable of driving it 130 mph, has an aluminum body with louvres from the front fender through the rear wheel housing. The cylinder block and head are made of cast aluminum alloy, replacing cast iron. The car has a crash type instrument panel, safety belts, hydraulic controls throughout, dual four-wheel brakes and built-in hydraulic jacks. It is 39.1 in. high at the cowl. Seated in the car is its designer, Charles A. Chayne.

Buick Motor Division

and high strength properties are obtained by heat treating after machining. One such steel which contains (percent) 0.25 C, 1.40 Mn, 1.50 Si, 1.80 Ni, and 0.04 Mo, can be heat treated to at least 220,000 psi tensile strength and an Izod impact strength of more 20 ft-lb. This unique combination of strength and toughness permits great reduction in size and weight savings in a new type landing gear (see illustration).

Aluminum

High temperature stress-rupture testing by the Naval Research Laboratory on wrought monel and 2-S aluminum, not only indicates a strong correlation between rupture life and grain size, but suggests that an intermediate grain size results in maximum rupture life. Study of the effects of welding technique and weld composition on the performance of aluminum alloy welds is expected to contribute to the development of improved, high strength joints.

Increased use of aluminum alloy die castings is a definite trend. For the future, high strength aluminum alloy sheet materials are a definite need. A formable sheet material of over 100,000 psi tensile, having a high yield strength could be used in both aircraft and ground vehicles.

Magnesium-Base Alloys*

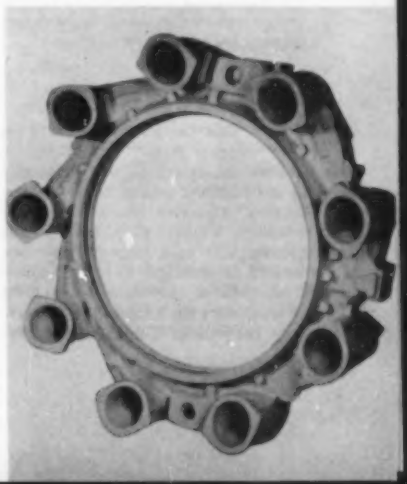
In the field of magnesium wrought alloys, the objective has been to develop an alloy with an ultimate tensile strength of 74,000 psi, a tensile yield strength of 68,000 psi, a compressive yield strength approximately equal to its tensile strength, with fire resistance characteristics similar to those of the AZ31 alloy to which beryllium has been added and other properties comparable to the commercial alloy formerly designated as AZ61. Certain magnesium-lithium-base alloys look promising, but at present they are brittle. Since these objectives seem to be long-range, research on a second group, magnesium-zinc-zirconium-base compositions, was instituted with new intermediate objectives:

1. An alloy with shop and service characteristics equal to present commercial magnesium alloys but with strength-weight ratios superior to 14 S aluminum alloy.

2. A sheet alloy at least equal in strength to present commercial magnesium compositions but with toughness and other shop and service characteristics superior to 61 S aluminum alloy.

Mg-Zn-Zr base alloy studies in the laboratory and on plant equipment have led to the selection of Mg-6Ag-6Zn-1Zr alloy, as the composition showing the most immediate promise for commercial development as high-strength sheet. These tests have demonstrated its comparatively good extrudability and rollability. Sheet has been produced in a variety of gauges, both clad and non-clad. Maximum properties are obtained by solution heat treating and aging hot rolled sheet. High strength combines with good hot formability are characteristic of this composition. One lot of 0.200 in. thick sheet produced with mill equipment and practice comparable to that used on the AZ31 commercial alloy had the following properties: Tensile strength 60,000 psi, tensile yield strength 48,000, compressive yield strength 40,000 psi and 4 percent elongation in the longitudinal direction and tensile strength 61,000 psi, tensile yield strength 49,000 psi, compressive yield strength 39,000 and 9 percent elongation in the transverse direction.

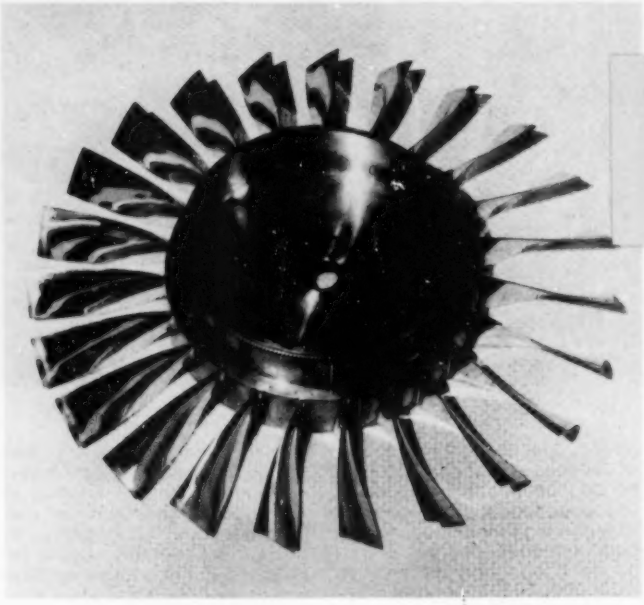
A Mg-6Ag-3Zn-1Zr alloy can be extruded in the form of a 10 in. I-beam and other structural shapes with typical properties of tensile strength 47,000 psi, tensile yield strength 38,000 psi, compressive yield



Remarkable resistance to creep at elevated temperatures is feature of new magnesium alloy, used in this 50 in. dia nozzle ring casting for Pratt and Whitney J-48 jet engine. Weighing 140 lb, the casting owes its excellent fatigue properties to composition of the magnesium alloy, which includes (percent): 0.55 to 0.85 of zirconium, 2.0 to 3.5 of zinc, and 2.5 to 4.0 of "rare earth" metals such as cerium and related elements.

Howard Foundry Company

*This section based on developments at the Engineer Research and Development Laboratories (Army), Fort Belvoir, Va.



Titanium gas turbine compressor wheel. Titanium is being considered as a replacement for conventional type 410 stainless steel as disk and blade material for jet engine compressors.

Rem-Cru Titanium, Inc.

strength 39,000 psi, and 11 percent elongation in the as-extruded condition. The yield strengths can be expected to increase to about 40,000 psi by age hardening heat treatment.

With lithium-containing alloys, tensile strengths as high as 86,000 psi were obtained with compositions such as Mg-7Li-20Zn-3Ce: Tensile strength 86,000 psi, tensile yield strength 56,000, compressive yield strength 62,000 and 1 percent elongation. Also, the highest compressive yield strengths known for magnesium-base alloys were obtained from Mg-7Li-25Zn, compressive yield strength 94,000 psi, and Mg-7Li-25Zn-5Ag, compressive yield strength 100,000 psi—but these high strength materials are still deficient in various design and service characteristics necessary for vehicle application.

Titanium

Now that the initial publicity on the "wonder metal" has faded, titanium can be evaluated realistically as a structural metal. These are the leading attractive characteristics of titanium alloys: (1) Low specific gravity; (2) high strength; (3) Retention of strength at intermediate temperatures; (4) attractive modulus of elasticity; (5) adaptability to surface hardening; (6) general resistance to environmental attack; (7) high melting point; (8) abundant availability of ore. Because its strength is equivalent to annealed stainless steel and its density is only 57 percent of it, titanium is being evaluated as a structural material for aircraft. One project is directed toward obtaining a high temperature-resistant, structurally efficient guided missile component completely constructed of titanium alloys. The other project calls for the design and fabrication of a complete aft fuselage section for a jet fighter, replacing all corrosion resistant alloy steels with titanium. This section will include titanium forgings and rivets as well as sheets.

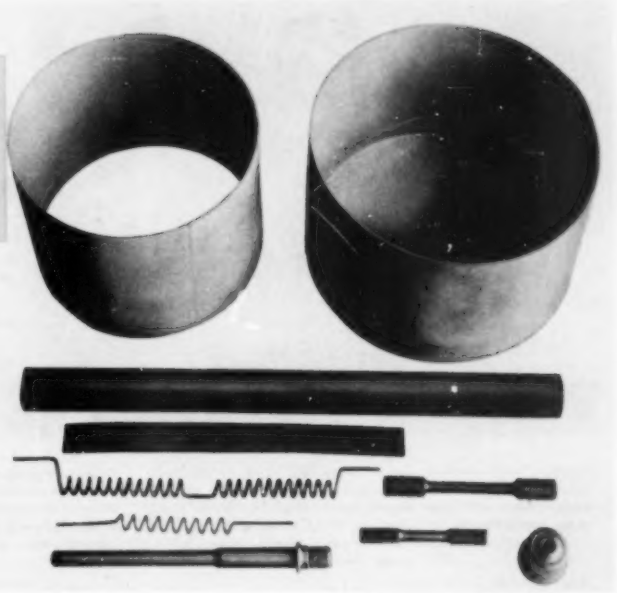
Engineers involved in titanium development feel that it will be possible to substitute titanium for stainless steel, thickness for thickness – with a 40 percent weight saving resulting. Portions of aircraft immediately surrounding jet engines, such as tail pipes and afterburner installations, will be particularly improved through use of titanium. Titanium base alloys are being considered to replace type 410 stainless steel as disc and blade material for jet engine compressors.

Outside of the aircraft field, titanium will be used in design of equipment exposed to marine and corrosive atmospheres, because of its outstanding resistance to chemical attack. Possibility of its use in land vehicles

Properties of Titanium Alloys in Two Forms

PROPERTY	SHEET (Longitudinal)	FORGINGS
	Rem-Cru RC-130-A (7%Mn)*	Mallory-BuAer Cr-Al†
Ultimate Tensile Strength, psi	150,000	170,000
Tensile Yield Strength, psi (0.2% offset)	140,000	155,000
Proportional Limit, psi	105,000	130,000
Elongation in 2 in., percent	15	10
Reduction in Area, percent	32	20
Modulus of Elasticity, psi‡	15.5×10^6	18×10^6
Specific Gravity	4.7	4.5
Fatigue Endurance Limit, psi@	70,000	95,000
Ratio $\frac{\text{Endurance Limit}}{\text{Tensile Strength}}$, percent	47	56

*Data from Rem-Cru Titanium, Inc.
†Data from Navy Bureau of Aeronautics
‡Varies with degree of cold work.
@Un-notched, reversed bending.



Siliconized coatings make use of molybdenum parts practical at high temperatures. At top, furnace baffle parts; below, tubing, strip, coiled wire, tensile test specimen, and thermocouple well nozzle.

Fansteel Metallurgical Corporation

is indicated by a new application developed by Army Ordnance. This is a mortar base plate which, when designed in steel weighed 48 lb and was in two parts; the titanium plate weighs only 24 lb and is designed in one part.

Properties of some titanium alloys are shown in the accompanying table. Even higher strengths will come with new titanium alloys, such as 5 percent chromium, 3 percent aluminum and alloys containing from 6 to 12 percent nickel. Potential uses for titanium where light weight and resistance to high temperature and corrosion are required, include: Springs, gears, portable machine tools, machine parts for the textile industry, pump rods or rotor shafts under packing materials where stainless steel often pits, and where mobile equipment to fill the gap between properties of aluminum and ferrous alloys.

Less Common Metals

Two years ago, titanium would have been included in the "less familiar" category. Now a new group of metals, some of which were used heretofore only as alloying elements, are on the horizon. These include zirconium, molybdenum, tantalum, columbium, even some in the "rare earth" category, up to now buried in the chemist's periodic chart.

ZIRCONIUM. The Bureau of Mines has developed a process for making ductile zirconium. The corrosion resistance of this metal is excellent, but it lacks the advantage of titanium's low specific gravity. Its excellent resistance to alkalies and certain acids may lead to replacement of platinum, tantalum and other expensive metals by zirconium, in chemical industries.

The cost of ductile zirconium remains too high for widespread use. However, the advances in production methods are continuing. The strength of the rolled or swaged metal is similar to that of the copper-base alloys. The drawn metal has a tensile strength in the range of that of annealed medium-carbon steel. The strength-weight ratio of zirconium is below that of magnesium, titanium, or the strong aluminum alloys. Corrosion data from the Foote Mineral Company show a corrosion rate of less than 0.001 inch per year in hot and cold hydrochloric acid of all concentrations, hot and cold 10% sulfuric acid, hot and cold nitric acid of all concentrations, hot and cold 10% phosphoric acid, and cold concentrated phosphoric acid. Attack is marked in concentrated sulfuric acid.

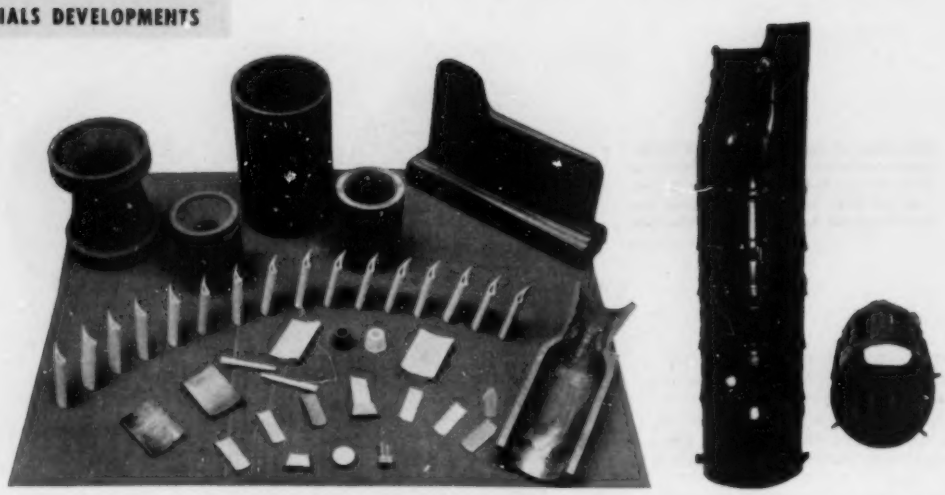
MOLYBDENUM. Because of its high melting point, molybdenum shows promise of becoming one of the basic materials for very high temperature structural applications. With the development of the arc-casting method, it is now possible to obtain ductile molybdenum in sections weighing as much as 150 lb, while equipment under construction will make it possible to increase this to 1000 lb.

Above 1600 F the creep and stress rupture of molybdenum are superior to those of the cobalt-iron or the chromium base alloys, but protection against oxidation is required. Ceramic coatings are being developed; at present, a "siliconized" coating looks promising. This molybdenum silicide coating is tightly adherent, electrically conductive, and highly resistant to thermal shock. Although the coating is extremely hard, coated molybdenum pieces can be worked to a limited extent at high temperatures. Indicated applications are for 2000-3000 F temperatures, far beyond the range of stainless steel and other nickel-chromium alloys, including such applications as gas and oil burner nozzles and jets, heating elements for electric furnaces, combustion chambers of gas turbine engines, and jet engine parts.

For the future, molybdenum will probably have the same relationship to the high temperature field that titanium will have to the lightweight structural field.

TANTALUM. Techniques for fabricating tantalum by sintering and swaging, rolling, and drawing have been developed. Alloys with columbium and molybdenum are resistant to a wide variety of mineral acids, even at moderately elevated temperatures. It is a safe prediction that these tantalum alloys will find wide application in the chemical industries.

For the not-too-distant future, the two metals that bear watching are chromium and vanadium. If they can be produced in ductile form at moderate cost, indicated applications are for 1,000-2,000 F temperatures, where corrosion-resistance is a factor.



Ceramic and ceramic-metal materials resist high temperatures in new flight requirements. (Illustration at left) Comparison of coated and uncoated metals: Lower right, steel rocket thrust cylinder shows corrosion after test; all other parts are ceramic or "cermet" coated. Upper, left to right, two ceramic-coated rocket nozzles, two ceramic-coated rocket combustion chamber liners, and an internal guide vane of a German V-2 rocket. (Photo at right)Two views of a combustion chamber liner made of low carbon steel, and coated with a specially-developed ceramic material.

USAF Air Material Command

New Ceramics . . .

Aid advances in high temperature, electronic fields

Inorganic mineral materials, often overlooked because of the publicity given the new "glamor" metals and plastics, are quietly but persistently finding a place for themselves in two important fields: (1) Materials extremely resistant to high temperatures and thermal shock for use in such applications as turbine blades and flame throats in jet and rocket motors; and (2) the development of ceramic capacitors of high-dielectric constant and low power loss for very compact radio and radar installations.

High Temperature Coatings

The increased demands for power in jet, rocket and internal combustion engines have called for operation at higher temperatures. Metals for such installations must not only have the toughness and strength but must also have the high melting point necessary. Unfortunately, the metals available in the requisite quantities necessary, notably molybdenum, are highly susceptible at operating temperatures to oxidation and other forms of corrosion. A combination of refractory oxides prepared by the National Bureau of Standards consisting of a large percentage of beryllium oxide with smaller amounts of alumina, zirconia and lime showed very promising properties.

However, "pure" ceramics – materials made from oxides, carbides, nitrides and the like – are still somewhat limited by some brittleness and sensitivity to thermal shock. The answer has come in the form of metal-ceramic combinations. For jet and gas turbine use, two different approaches are being attempted, both apparently successful:

1. The National Bureau of Standards coating is a metal-ceramic combination applied as follows: During heating to cement the coating to the base metal, metal powder incorporated in the mixture is welded by diffusion to the base metal, providing a firm and very adherent intermediate layer. An all-ceramic outer layer provides additional protection.

2. Certain armed forces branches, such as the Air Material Command, are utilizing the "ceramets" which are a pre-mixed combination of metals such as chromium with a "ceramic" portion such as aluminum oxide. These have better thermal shock resistance and ductility than ceramics; some mixtures can be machined. They have a lower melting point than ceramics, but are still in the high temperature range.

PORCELAIN ENAMEL COATINGS FOR STEEL. A new type of ceramic coating for the protection of mild steels in high-temperature service has been developed at the National Bureau of Standards, and was used by the Army and Navy on the exhaust systems of certain aircraft and other vehicles. Laboratory and service tests have shown these new coatings to be superior to conventional porcelain enamels for high-temperature service. The outstanding features of the coatings are: (a) High resistance to chipping under repeated severe thermal shock, (b) protection of the metal against oxidation during prolonged exposure in air at temperatures up to about 1,250 F, (c) freedom from the cracking and blistering produced in conventional porcelain enamels under comparable conditions of high temperatures and severe thermal gradients; and (d) a matte surface that does not show highlights and, therefore, decreases the visibility.

To prepare these coatings, a mixture of a special grade of calcined aluminum oxide and a conventional type of porcelain enamel ground-coat

Above — Made of synthetic mica produced by the Electrotechnical Laboratory, U. S. Bureau of Mines, these are typical parts that might be used as dielectric components of electronic equipment. Easily machined from semi-finished shapes, the new material promises to free the United States from dependence on foreign sources for natural mica.

Office of Naval Research

Left — New ceramic coating protects low carbon steel exhaust stacks: Shown after 300 hr simultaneous flying test on a Navy patrol bomber, stack on left is coated with Bureau of Standards material, while stack on right, which is coated with conventional porcelain enamel, shows blisters and rusting.

National Bureau of Standards

frit is ground with water to appropriate fineness and is then applied to the metal, dried, and fired according to well-known methods. The coatings can be used on low-carbon steel in an unprecedentedly thin application of only 0.002 to 0.003 inch.

In addition to the use of the new coatings for the protection of low-carbon steel in various military exhaust systems, there are a number of other possible applications where the new coatings, or modifications of them, might be beneficial in prolonging the life of steel parts that are subjected to relatively severe temperature conditions. A list of such potential applications would include: (1) Domestic stove parts, such as grates or burners; (2) industrial furnace parts, such as muffles, dampers, or burners; (3) parts for heat interchangers; (4) heat baffles for continuous enameling furnaces; (5) annealing boxes; and (6) mufflers and tail pipes for buses, trucks, and automobiles.

New Ceramic Dielectrics

The development of synthetic mica promises to be of widespread importance, not only to the electronic industry, but to the nation's economy as a whole, because it will eventually free us from dependence on India for natural mica. Developed by the Electrotechnical Laboratory, U. S. Bureau of Mines, Norris, Tennessee, in cooperation with the Office of Naval Research, the Bureau of Ships, and the Army Signal Corps, the new material is known as "polycrystalline synthetic fluorine-phlogopite mica." It is made by sintering or hot pressing from relatively inexpensive chemical raw materials.

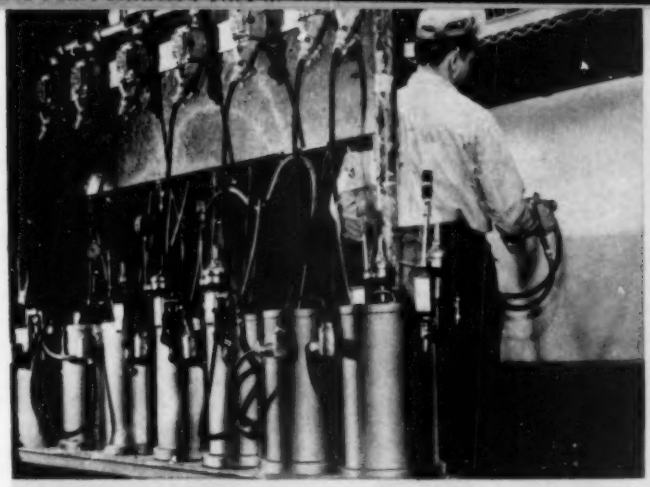
Principal application of the new material will be as dielectric parts in high frequency communications and high voltage equipment. Its dielectric properties compare very favorably with glass-bonded natural mica (Mycalex), and potential cost is much lower. Upper limit of safe operating temperature for the synthetic is about 800 C, while for Mycalex it is about 350 C. Chemical stability of the synthetic is about the same as for natural mica. Data on the dielectric strength of "type A" material shows that the synthetic mica meets the Joint Army-Navy Specification of 180 volts per mil minimum; maximum value reported is about 400 volts per mil.

Flexural strength measurements on 2 in. rods show values of about 7500 psi. Hardness is low – Knoop diamond indentation hardness of about 40. But one of the most important properties of the new material is its machinability: It can be sawed, drilled, turned on a lathe, and cut with ordinary metal-working tools to very close tolerances with relative ease. Right now shapes are machined from semi-finished forms such as bars. However, pressed sheet suitable for stamping operations is expected to be developed at an early date.

Another possible application for synthetic mica is as a heat insulator. It is porous, and can be pressed into a variety of shapes; its load-bearing strength should be adequate for many products.

TITANATE DIELECTRICS. The very remarkable dielectric properties of some of the titanates of the alkaline and rare earth metals are being utilized for capacitors by an ingenious combination of extremely thin discs, each disc varying slightly in composition so that the whole provides a material with a high dielectric constant over a wide temperature range. Development of these materials – strontium and especially barium titanate – grew out of the mica shortage of the last war. They are especially interesting for their piezoelectric properties – ability to vary their dielectric constants with temperature and physical pressure. One use of such materials is as a pickup element in either static or dynamic pressure gages. Barium titanate should become a "must" material in electronic circuits, if present trends continue.

Wider Application Horizons For Organic Finishes



Hot spraying of paint and lacquer enables higher solids content at the gun, thus requiring fewer coats and giving better film properties. Equipment used to spray steel panels includes these paint heaters which maintain a constant temperature.
Bode Products Inc.

Perhaps the most outstanding trend in the organic coating field is away from the oleoresinous paints, which utilize linseed, tung and similar oils as "film-formers." These coatings are being rapidly displaced by the newer synthetic resin base coatings. And even within the synthetic resin coatings, new developments are coming rapidly: New heat-resistant, chemical-resistant, and abrasion-resistant films of the baking type have been announced. For the future, harder, tougher and more chemical-resistant films of the room-temperature-setting type can be expected.

Following are a few of the new developments that should reach their peak in the next decade.

SILICONE FINISHES. Outstanding heat stability, excellent weather and chemical resistance, color and gloss retention above 400 F, and low temperature flexibility are characteristic of silicone resins. Enamels based on these, particularly those pigmented with aluminum powder, have found wide application for stacks, boilers, furnaces, incinerators, steam lines, exhaust systems, heat exchangers, arc light reflectors and the like. Other colored enamels have gone into resistor coatings, identification markings for welding rods and electronic tubes. On the debit side, however, are these inherent weaknesses: Low solvent resistance, thermoplasticity, poor adhesion to steel, incompatibility with most organic film formers, and the high temperature needed for curving.

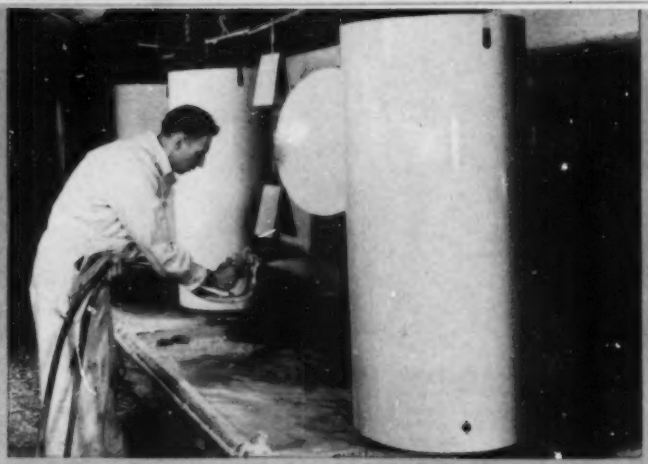
New modifications, however, promise to overcome these difficulties. Principal among these is a group of silicone-alkyd coating resins. Films formulated with silicone-alkyd display a heat resistance considerably higher than most purely organic films. They maintain high gloss and stable color in the range of 400 to 500 F. At 450 F, for instance, a Plaskon coating resin, when properly formulated and correctly applied, maintains high gloss and film integrity for more than 300 hr. Hardness and abrasion resistance are equal to or better than the best melamine-alkyd combinations; adhesion and flexibility are as good as the best organic coatings.

Properties of the silicone-alkyd coatings place them somewhere between organic and porcelain enamel coatings. In addition to good heat resistance, their main advantage is their ability to be applied on steel without a primer. Although original material cost is higher than porcelain enamels, ease of application greatly offsets this difference. A new member of this group – a baking aluminized alkyd-silicone type – is reported to withstand temperatures up to 1500 Fahrenheit. If such finishes can be made economically feasible, a trend toward silicone coatings can be expected in kitchen ovens and similar appliances.

HOT SPRAYING. There has been a steady improvement in the application of automotive finishes – principally through increasing the solids content coming from the spray gun, so that fewer coats are required to achieve a given thickness. Solids content (by volume, at the gun) of automotive synthetic enamels applied in 1926 was about 10 percent; this increased to about 22 percent in 1947. Now, a new basic improvement has been developed: Hot spraying of lacquers and enamels.

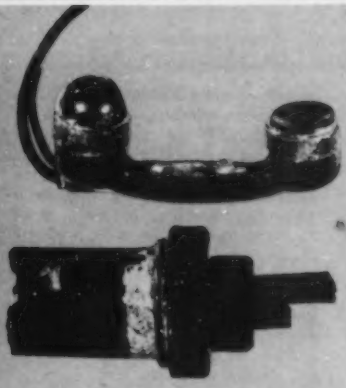
In this process, reduction to spraying viscosity is achieved by heating the lacquer to approximately 160 F instead of depending entirely on the use of thinners. Safety precautions are the same as for cold spray lacquer. Basically, there is no difference in the quality of finish, or in composition of solids, between hot-sprayed and cold-sprayed lacquers. However, fast evaporating solvents are almost eliminated. Solids content is increased to 33 to 35 percent, and number of coats is correspondingly fewer. For automotive application, cold lacquer requires 3 double coats, while hot lacquer gives the same finish in 1 or 2 coats. Material and labor costs are correspondingly reduced. In addition, less sanding and polishing are required.

These advantages are also obtained with hot spraying of synthetic resin base paint (enamel). Spraying temperature is about 175 Fahrenheit. The paint dries to a better gloss and without runs, sags or "orange peel." A manufacturer of lighting equipment reports that finishing fluorescent fixtures by the new method has resulted in a 99 percent drop in rejects. Success of the method is partly through development of new equipment. Lower air pressure is used, reducing "over-



Large scale finishing operations, such as painting of water heater assembly, are suitable for steam spraying. The spray gun was specially developed to meet unusual requirements of steam spraying, without danger to the operator.

Kalamazoo Division, American Brake Shoe Company.



Marine hand telephone shows fungus growth on cable and phenolic case and corrosion on metal portions; the hand button is often "frozen" by corrosion. Cable connector shows similar fungus and corrosion. New fungus- and moisture-resistant finishes prevent such effects.

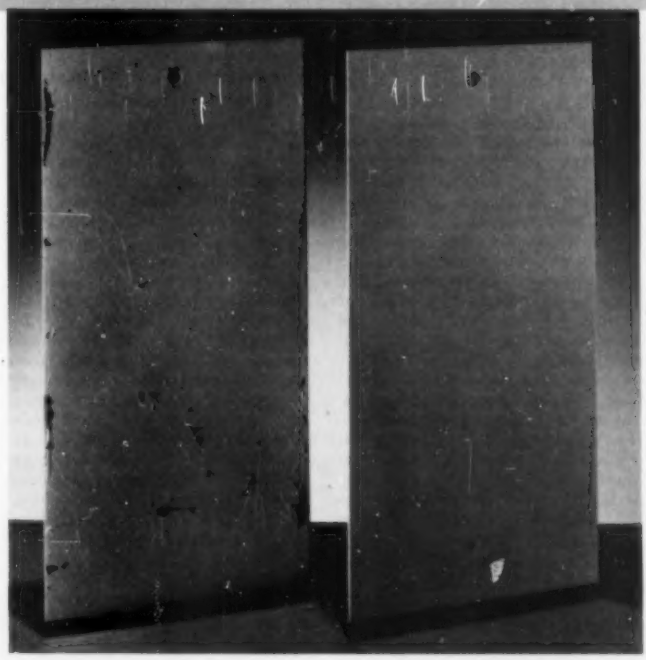
Lacquer and Chemical Corp.

spray"; and a new paint heater using aluminum as the heat transfer medium comes to operating temperature within 15 min and has a heating coil for air so that it can be operated in cold weather.

STEAM SPRAYING. Of equal importance to the hot spraying method, a new steam spray process has been developed by DuPont for use in continuous, high volume finishing operations. This method requires completely new equipment for spraying paint with steam, including a new sray gun using super-heated steam at 60-100 psi instead of compressed air. The use of dry, superheated steam as an atomizing medium serves to heat the finishing material, making it possible to use materials of higher viscosity. This allows the application of heavier coats without sagging or running. Danger of "pinholing" and "popping" is reduced.

In many cases the material thickness per coat can be substantially increased by steam application. Because of the characteristics of steam, finishing material savings of ten to twenty percent can be expected in most applications through the reduction of overspray and atomization losses. In addition, savings in solvents and thinners are realized through the use of finishing materials higher in solids.

The steam spraying method does not seem suitable for such applications as automobile bodies but smaller metal products, which can be handled in regular spray-booth, assembly-line large-volume operations, should be perfectly adaptable to the new process. Also, it would appear to be better suited for the spraying of paint than for lacquer; a saving in baki..g time would result from its use.



Heat resistant organic coatings — These panels, coated with pastel shade enamel, were exposed to 350 F for 30 hr. The conventional melamine-alkyd enamel at left failed, while new silicone-alkyd film showed no effects; same film was subjected to 350 F for 500 hr and 450 F for 300 hr with no loss of gloss or other properties.

Pittsburgh Division, Libbey-Owens-Ford Glass Company.

FUNGICIDAL VARNISHES AND LACQUERS.* World War II awakened designers of electrical equipment to the dangers of fungus growth. In some war materiel, all organic ma-

*This section based on information furnished by Lacquer and Chemical Corporation.

terials – plastic insulation, and finishes–were affected, often completely destroying the value of equipment when corrosion of metallic parts was associated with it. Now designers are considering this as a peacetime problem as well, since so many markets for their products are in tropical and semi-tropical locations – which includes a sizeable portion of the United States. Fungus-resistant organic coatings are already specified by the military and can be considered "on the way" for civilian products.

Although there are many compounds which exhibit fungicidal properties, stringent requirements cut the number which can be used with lacquers and varnishes down to a few. A fungicide must possess the following properties to be suitable for use in a lacquer or varnish: (1) Must show satisfactory fungus-inhibiting properties against the fungi affecting the materials and equipment even when used in small concentrations; (2) must not be leached by water from the dried film; (3) must be soluble in the volatile component of the varnish or lacquer; (4) must be stable when incorporated into the lacquer or varnish; and (5) must be stable at elevated temperatures.

The fungicides that have been found useful for fungicidal lacquers and varnishes are in two general classes: (a) Those depending on metals for their action, and (b) those depending on organic radicals and non-metallic elements such as chlorine for their action. The former class is more efficient since the quantity of fungicide needed is much less than in the case of the metal-less fungicides. The major drawback in the metal fungicides is the effect they may have on certain electronic components such as unprotected selenium rectifiers.

As shown in the following list, tests have shown that combinations of fungistatic agents prove more effective than the individual fungicides. The combination of one percent phenyl mercuric ortho benzoic sulphimide and five percent salicylanilide has proven to be effective against the fungi which affect electronic equipment.

Fungicide	Percentage effective against mixture of test fungi
Phenyl mercuric ortho benzoic sulphimide	1.5
Copper-8-quinolinolate	2.0
Salicylanilide	8.0
Pentachlorophenol	15.0
Mixed fungicides: Phenyl mercuric orthobenzoic sulphimide + Salicylanilide	1.0 + 5.0

Along with the anti-fungus treatment, materials which increase moisture resistance are incorporated into these finishes. Thus, the complicating factor of metallic corrosion is eliminated. A fair prediction can be made that such finishes will become standard for all electrical and electronic equipment destined for "world-wide" use.

Superior corrosion and "abuse" resistance of new vinyl coatings is evident in battery tray at right, which shows no corrosion after two years' service. At left, after three years' service, battery tray painted with asphaltum plainly shows corrosion effects. Vinyl coating also has superior resistance to chipping in impact tests.

The Electric Storage Battery Company.

New Vinyl Coatings. Another outstanding trend in the organic coating field is the use of specialty coatings for resistance to corrosive chemicals and physical abuse in industrial applications. Specifications for such coatings include economy and ease of application – usually by spraying or dipping, directly on the degreased metal surface.

The vinyl-base coatings seem to hold the answer to this group of requirements. Metallic powders, such as stainless steel, zinc and aluminum, are easily incorporated, where increased corrosion resistance is desired. Such coatings are often expendable – an example is the "strippable" coatings which were developed for temporary protection of ordnance equipment, are now in widespread use for storage and shipping protection of machine tools. These coatings are usually applied as a lacquer – by solvent evaporation; or as a suspension in a non-solvent. Most industrial applications utilize the lacquer method.

An application that combines all of the aforementioned requirements is the use of a vinyl coating to protect steel battery trays against small amounts of acid that accumulate outside storage batteries. This was first developed as a corrosion proof vinyl coating to protect aluminum alloy battery compartments in military airplanes. Since the new coating protected corrosion sensitive aluminum alloy against the action of acid, experiments were tried on sheet steel, which proved successful. If the surface is scraped exposing the bare steel, corrosion is limited to that area, because of the tight bond formed between the coating and the metal surface.

The bond to the steel tray is claimed to enable the coating to withstand mechanical abuse from blows and abrasion without flaking off. Tests indicate that the new coating holds even when the blow is heavy enough to dent the steel. Another characteristic claimed for this coating is its high insulating quality. This protects the steel from corrosion due to the leakage of current.

Dip coatings of vinyl dispersions – "organosols" and "plastisols" – are being used in similar applications: A promising example is its use to protect plating racks against the corrosive action of plating solutions. For practical purposes the process is called plastisol if less than 5 percent of volatile liquids are used, organosol if the amount is greater. Film formers are polymerized vinyl resins such as vinyl chloride and vinyl chloride-acetate. The organosol process permits the use of resins of higher molecular weight than can be normally used in other processes, resulting in films and coatings of added toughness and strength. The resins commonly used are Bakelite's Vinylite VYNV-1 or Goodrich's Geon 121. It is a multicoat process, permitting varying properties in base and top layers. The relative absence of heat and pressure in the process keeps the degradation of the resin at a minimum, assuring long life and excellent ageing qualities. The film produced also has no directional characteristics in either tear or tensile strength, thus preventing warping or buckling.

What 80 Major Companies Are Doing Today

To get the answers to some common problems and to determine how some of the major industrial centers are faring as a result of materials cutbacks and increased activity on military contracts, PRODUCT ENGINEERING conducted a spot survey of 80 companies in the following cities: Milwaukee, Boston, Cleveland, Pittsburgh, Detroit, Dallas, Los Angeles and San Francisco and Buffalo.

Indications are that

1. Both original and redesign is approaching a peak level.
2. There is even more military design work being carried on than is generally realized.
3. A large number of companies are expanding their engineering departments.
4. The shortage of engineers is beginning to hurt.
5. Many of the bigger companies have large military orders on hand already, and the smaller ones are working on a subcontract basis.
6. Almost all plants are at or near capacity and those who are not have been forced to cut back because of materials shortages.

Milwaukee

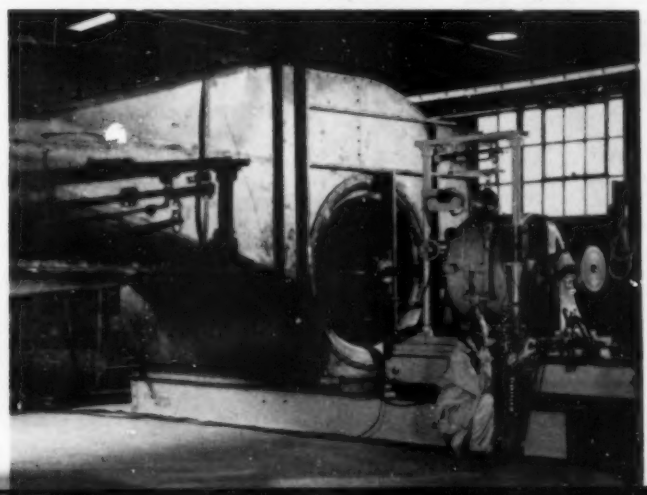
The current emphasis on military equipment has not yet affected the improvement of old products or the design of new ones. As a matter of fact, a survey of 16 large nationally known firms in this area making products ranging from electric motors, X-ray equipment, power transmission devices and internal combustion engines to coatings and welding electrodes indicates that, if anything, design activity has increased with the improvement in general business conditions since the middle of last year.

Of the concerns contacted, 14 said that they were continuing to improve their older products, and eleven stated specifically that they have a continuing program of research and development underway that so far has not been affected by military orders or shortages of materials.

The reasons listed for redesign include: (1) compensate for shortages of materials, (2) reduce costs, (3) increase efficiency of operation, (4) increase productivity, (5) simplify operations, (6) improve quality, (7) decrease weight, and (8) improve appearance. Indirectly, many of the reasons given tie in with the materials allocations program.

About half of the firms said that they were working on both military and commercial designs. Of the others five said that they were concerned primarily with commercial products but were doing some military work, while the others either did not answer or else simply indicated that all of their work was on commercial products. Thus, it is safe to say that while the swing to military production has not yet affected much of the manufacturing capacity of plants in this area, the design departments are busy with proposed military products or are working under developmental contracts for one of the branches of the armed services.

Checking performance data on large fan at Buffalo Forge Company.



Cleveland

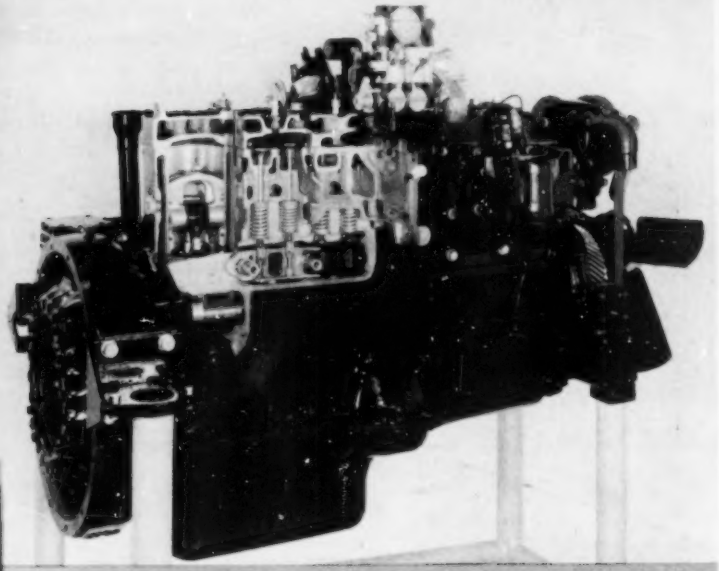
This highly industrial center is operating in high gear. Present conditions are best reflected by the number of concerns planning to substantially increase their productive capacity and to add to their engineering staff; and also by the number who have large numbers of military contracts. Here are some examples taken at random from a survey of 20 firms:

1. Have a large number of defense contracts but can't give any ratio of commercial to military volume.
2. Four firms, asked about defense contracts, simply stated that they have a large number. Still another was devoting 50 percent of design time to military work. The design department of one of these firms – a large company – is 60 percent on original design for the military.
3. One firm has only 5 percent on prime contracts at the present time, but are nearly 100 percent on subcontracts.
4. Have nearly a $5,000,000 order, which will require 15 to 20 percent increase in plant capacity and addition of approximately 250 employees.
5. About 90 percent of production is in DO sub-contracts now and have a few contracts with arsenals.

Of the other concerns answering, the average total volume of defense contracts totaled only about 5 percent of the overall volume of business.

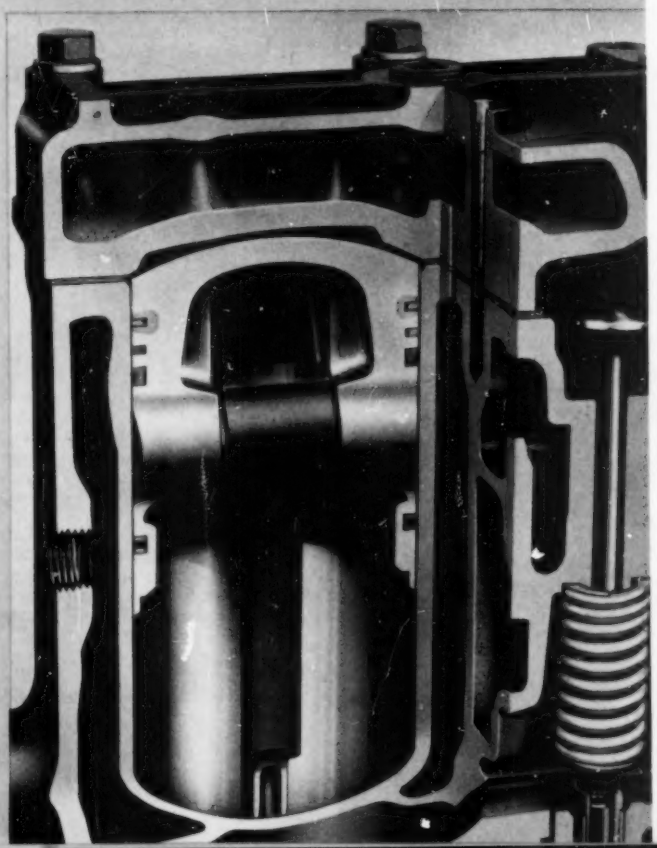
However, the total volume of all business is up substantially. One manufacturer gave as his objective a 50 percent increase in production. Another noted that his productive capacity has doubled since 1947.

One thing seems certain, manpower – particularly skilled designers – are in short supply and will



White Motor Company's new Mustang engine, rated 150 hp at 3,000 rpm. Having a higher compression ratio (6¾ to 1) and less weight per hp (6¾ lb/hp) than previous models, it typifies trend toward higher engine ratings and improved fuel consumption per bhp-hr.

One feature of the Mustang is a ribbed cylinder head with pillars between the top of the combustion chamber wall and top of cylinder head to obtain greater rigidity. Pillars also are used from top to bottom of cylinder block to reduce wall stresses.



be even shorter. The same applies, although not to the same extent, to factory workers. "We can get the equipment but we don't know whether we can get anyone to work at it," was the way one manufacturer put it. But another said: "It is hard to get *competent* personnel, but it is not much trouble to get trained technical personnel as long as we pay them enough."

Boston

Boston and surrounding areas undoubtedly have not yet been affected to any appreciable degree by the influx of substantial military orders. This is not surprising since the highly industrial centers such as Pittsburgh, Detroit and other mid-western cities have been the first to get firm military contracts.

Very few firms in this New England community are planning, as of now, to increase the size of their design departments. Their attitude is one of wait and see. When the time comes, they evidently believe they can expand as required.

Most of the concerns stated that they were having no difficulty in obtaining a sufficient number of trained engineering personnel, as of now. One said that his problem was the replacement of young engineers now being drafted, but that problem is common throughout the country. The older and more experienced man can now command a premium for his services. In all communities, it is surprising the number of engineers who are shopping around to see what they can gain financially by making a switch from their present position.

Of course, none of the above applies to the big electronics outfits in Cambridge and Waltham. Both Raytheon and General Radio are operating at capacity and on the influx of military orders for radar and communications equipment. Even if the projected military orders are to be filled, such concerns are in for substantial expansion.

Pittsburgh

The big news in this industrial center is materials. So the swing to military production can be made without too much notice. It simply means a change in customers. To a large extent, this has already been done.

Even the substantial electrical industry in this area does not face much of a conversion problem primarily because industrial, rather

than consumer goods, are made in the majority of plants, and while changing from central station switchgear to equipment for Naval vessels does mean a design change, it does not necessarily require complete revamping of existing production lines. As a matter of fact, most of the concerns in Pittsburgh have done an appreciable business since the end of World War II, either directly or indirectly, with the armed services.

Pittsburgh is of course one of the most dynamic industrial centers in the country and probably ranks high in the dollar volume of industrial research done per year. Industrial giants such as Alcoa, Westinghouse Electric Corp., Blaw Knox, Dravo, National Steel Co., Allegheny Ludlum and others have extensive research facilities in the vicinity. Here are some of the developments under way:

1. Atomic reactors for shipboard use
2. Gas turbines for shipboard
3. Improved lubrication and lubricants for processes and equipment
4. Use of radioactive energy for end product applications
5. Alloys of titanium and equipment for fabricating them
6. Gas turbine locomotives
7. High strength aluminum

Dallas

Except for the aircraft companies, there is a uniformity of condition in Dallas and Houston indicating (1) that few of the larger concerns have made any effort to obtain military contracts, probably because (2) they are working at or near capacity, within restrictions imposed by materials shortages. The other reason—which also is partially responsible—is that the specialized products made by these companies would necessitate extensive retooling and plant rearrangement before contracts could be fulfilled—and at the expense of the expanding petroleum and chemical industry in the south and southwest.

Hydraulic torque converters, of course, have swept the oil industry. For oil well drilling equipment and other field machines, the torque converter has proven ideal.

Los Angeles-San Francisco

Design activity on the west coast is paced by the aircraft industry. Right now it is accelerating rapidly. Howard Hughes is reportedly building up a high engineering staff for work on guided missiles, and all of the aircraft companies are expanding design departments that are large by ordinary standards. For example, one aircraft manufacturer reports that the engineering department numbers over 2,000 engineers — and more are needed.

This revitalization has had a big effect on component manufacturers — of pneumatic and hydraulic pumps, valves and other system components as well as electrical manufacturers.

Although it is impossible to list specific projects on which many of these companies are working because of military security, some of the general trends are as follows:

1. Higher pressures for both hydraulic and pneumatic control systems (see Hydraulics).
2. Application of new materials, including plastics and titanium.
3. Development and refinement of new processes such as hot forming of light alloys, broadening of new welding techniques, use of integrally stiffened structures.
4. Application of gas turbine power to large aircraft for jet propulsion, and turbo-prop power.
5. Guided missiles.
6. Better specifications, with only *necessary* requirements and limitations included, rather than theoretical.
7. Emphasis on helicopters, high speed aircraft, rocket engines, and new propellants.

Summary of Design Activity

1. Are you doing much original design or redesign?

Original	19
Redesign	10
Both	40

2. If so, is it primarily on military or commercial equipment?

Military	11
Commercial	34
Both	24

3. Do you expect to expand your engineering department?

No	21
Yes	34
10-20%	2
20-50%	4
Over 50%	4

4. Are you having difficulty in obtaining trained technical personnel?

Yes	57
No	16

5. Do you have a large number of defense contracts?

No	17
Yes	32
Some	14

6. Are you operating at capacity or near capacity?

No	6
Near capacity	29
At capacity	28
Expanding plant	4

Detroit

The automotive companies in Detroit still do not know, as of this writing, what they are in for not only in terms of production cutbacks but also in terms of engineering developments. Large military contracts may soon force drastic curtailment of civilian engineering development except that of a minor nature. One firm, for example, stated that it was impossible to "program engineering developments with any degree of accuracy because of the confusion in defense business." Chances are, however, that this phase of operations will be less affected than some top officials now expect — just as, in spite of dire predictions, the switchover to military work has resulted in fewer stoppages and lay-offs than these same officials anticipated.

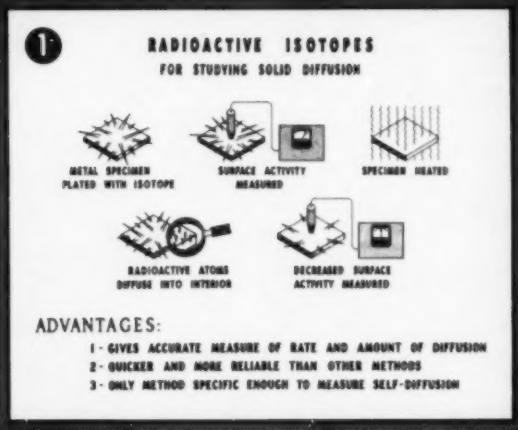
The big design development work in the automobile industry seems to be primarily on transmissions, secondarily on high-output high-compression engines. This applies to all the automotive companies uniformly.

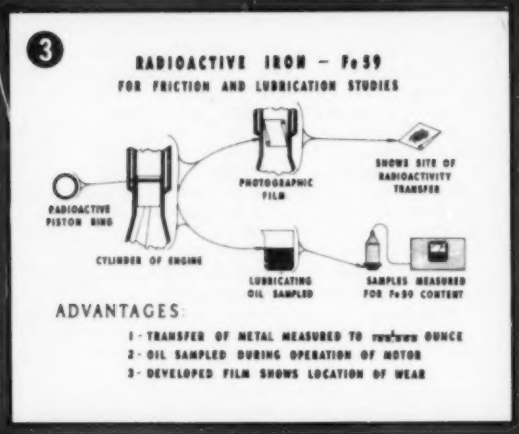
Of companies contacted, most indicated that they were having a difficult time obtaining sufficient engineering personnel; most were operating at or near capacity; and about half had "substantial" military contracts—the rest having little or none.

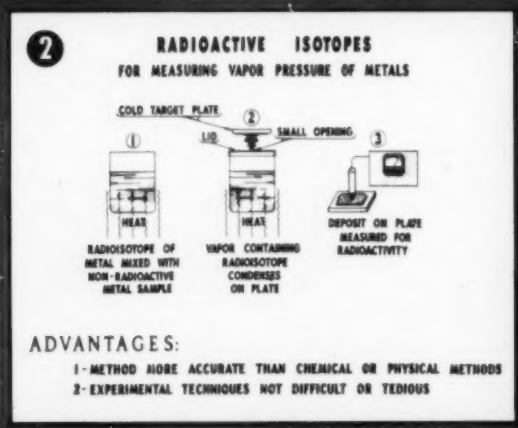
Buffalo

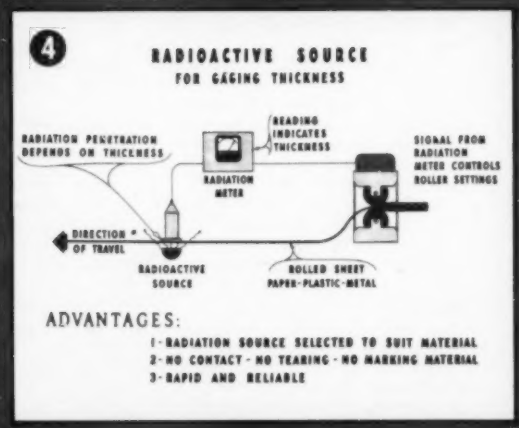
Defense contracts are definitely appearing in greater numbers in the Niagara Frontier area. At a guess, there is 15 to 20 percent of total manufacturing business in defense contracts in process and they are increasing daily. Probably none of the plants, with the exception of the steel mills are operating at full capacity, but many are near capacity and a few are working overtime.

One engineer manager made a very significant remark when queried about the redesign of equipment: that he could see no prospect of lower cost products.


1
RADIOACTIVE ISOTOPES
FOR STUDYING SOLID DIFFUSION
METAL SPECIMEN PLATED WITH ISOTOPE
SURFACE ACTIVITY MEASURED
SPECIMEN HEATED
RADIOACTIVE ATOMS DIFFUSE INTO INTERIOR
DECREASED SURFACE ACTIVITY MEASURED
ADVANTAGES:
1 - GIVES ACCURATE MEASURE OF RATE AND AMOUNT OF DIFFUSION
2 - QUICKER AND MORE RELIABLE THAN OTHER METHODS
3 - ONLY METHOD SPECIFIC ENOUGH TO MEASURE SELF-DIFFUSION


3
RADIOACTIVE IRON - Fe 59
FOR FRICTION AND LUBRICATION STUDIES
RADIOACTIVE PISTON RING
CYLINDER OF ENGINE
PHOTOGRAPHIC FILM
SHOWS SITE OF RADIOACTIVITY TRANSFER
LUBRICATING OIL SAMPLED
SAMPLES MEASURED FOR Fe 59 CONTENT
ADVANTAGES:
1 - TRANSFER OF METAL MEASURED TO [illegible] OUNCE
2 - OIL SAMPLED DURING OPERATION OF MOTOR
3 - DEVELOPED FILM SHOWS LOCATION OF WEAR


2
RADIOACTIVE ISOTOPES
FOR MEASURING VAPOR PRESSURE OF METALS
COLD TARGET PLATE
LID
SMALL OPENING
HEAT
HEAT
RADIOISOTOPE OF METAL MIXED WITH NON-RADIOACTIVE METAL SAMPLE
VAPOR CONTAINING RADIOISOTOPE CONDENSES ON PLATE
DEPOSIT ON PLATE MEASURED FOR RADIOACTIVITY
ADVANTAGES:
1 - METHOD MORE ACCURATE THAN CHEMICAL OR PHYSICAL METHODS
2 - EXPERIMENTAL TECHNIQUES NOT DIFFICULT OR TEDIOUS


4
RADIOACTIVE SOURCE
FOR GAGING THICKNESS
RADIATION PENETRATION DEPENDS ON THICKNESS
READING INDICATES THICKNESS
RADIATION METER
SIGNAL FROM RADIATION METER CONTROLS ROLLER SETTINGS
DIRECTION OF TRAVEL
RADIOACTIVE SOURCE
ROLLED SHEET PAPER-PLASTIC-METAL
ADVANTAGES:
1 - RADIATION SOURCE SELECTED TO SUIT MATERIAL
2 - NO CONTACT - NO TEARING - NO MARKING MATERIAL
3 - RAPID AND RELIABLE

RADIOISOTOPES in Industry and Research...

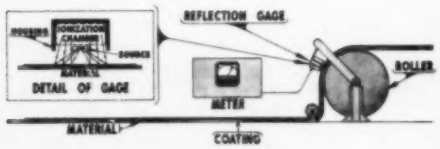
1. Research workers at the Metals Research Laboratory of Carnegie Institute of Technology have used radiotracers to measure self-diffusion coefficients in both iron and cobalt. The radioactive material is plated on a disk and a measurement made of the amount of activity on the surface. The sample is then heat-treated and a second measurement made. The decrease in the amount of surface activity is a measurement of the diffusion that has taken place. The same technique can be used to measure the diffusion between both like and unlike metals and is less difficult than chemical analyses methods.

2. Method used in measuring vapor pressure of metals. Vapor emanating from the hot metal sample mixed with a radioisotope passes through the small orifice opening in the cover of container. The stream of vapor is then condensed on a cold target plate. The measurement of radioactivity in the deposit on the plate indicates amount of metal evaporated from sample.

3. Technique of investigating engine wear with piston rings made radioactive in a nuclear reactor. Test is made with great accuracy in a short period of time. While the engine is running, radioactive particles worn off the rings drop into the lubricating oil, which is sampled and measured for radioactivity content. Photographic film placed in contact with cylinder wall yields a record of the zone of wear.

4. Radioactive thickness gages of the absorption type are being routinely employed to measure the thicknesses of metallic and nonmetallic sheet and foil materials. The sheet material to be measured travels between the radioactive source and the detector. A part of the radiation is absorbed by the sheet material in proportion to its weight per unit area. A calibrated meter or recorder connected to the detector indicates the weight per unit area of the sheet. No physical contact is made with the material.

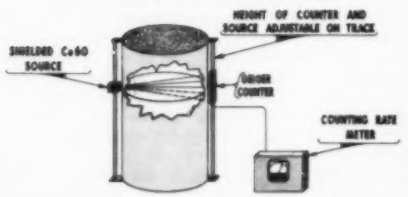
5 RADIOACTIVE SOURCE
FOR REFLECTION (BACKSCATTERING) THICKNESS GAGE



ADVANTAGES:

1 - CAN MEASURE THICKNESS OF COATING AND/OR MATERIAL
2 - MEASUREMENT MADE FROM ONE ACCESSIBLE SIDE
3 - CAN MEASURE A VARIETY OF MATERIALS WITH ONE CALIBRATION

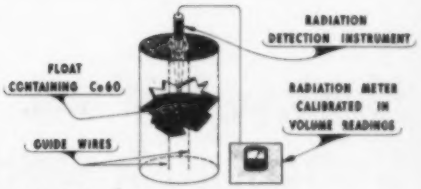
6 RADIOACTIVE COBALT - Co60
FOR INDICATING LIQUID HEIGHT



ADVANTAGES:

1 - GAGE NOT AFFECTED BY CORROSION AND TEMPERATURE
2 - CAN BE OPERATED BY NON-TECHNICAL PERSONNEL
3 - ADAPTABLE TO AUTOMATIC RECORDING AND CONTROL OF LIQUID LEVEL

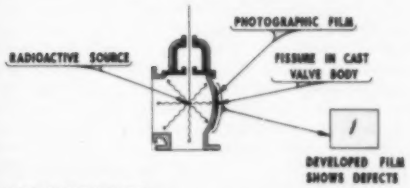
7 RADIOACTIVE COBALT - Co60
FOR LIQUID LEVEL GAGE



ADVANTAGES:

1 - CONTINUOUS RECORDING
2 - MEASUREMENT MADE ON CLOSED SYSTEM
3 - ADAPTABLE TO AUTOMATIC CONTROL

8 RADIOACTIVE COBALT - Co60
FOR RADIOGRAPHY TESTING



ADVANTAGES:

1 - VERSATILE AND RELIABLE INSPECTION
2 - INSPECTION MADE WITHOUT DISMANTLING
3 - SOURCES OF DESIRED SHAPE AND SIZE
4 - VERY HIGH ACTIVITY SOURCES AVAILABLE AT LOW COST

Radiomaterials have been used as tracer atoms in investigations that include friction, vulcanization, corrosion, catalyses, detergency, diffusion, steel-making and some types of plant process control.

5. Backscattering type thickness gages measure nondestructively the thickness of applied and electrodeposited coatings on all types of backing materials while the sheets or film is on a rotating roll, and measurement is accessible only from one direction. The source of radiation is housed in a unit with the ionization chamber. The ionization chamber is actuated by rays reflected from the material. The resulting chamber current determines the reading of the meter.

6. Radioactive height gage to measure the amount of liquid steel in a furnace or cupola. Gage is operated from outside the cupola and is not affected by the surrounding heat. The radioactive cobalt source is mounted outside the cupola and the detection instrument is mounted at the same height on the opposite side. When the molten steel rises above the radioactive source, part of the radiation is absorbed thus the amount of that reaching the counter is decreased.

7. Liquid level gage uses a radiation detection instrument and a guided float containing radioactive cobalt. This gage is particularly useful where highly corrosive liquids are to be measured, or where it is desired that the tank have no openings through which gas or vapor can leak. The float is constrained to move vertically in the tank. The detection instrument is mounted outside the tank directly above the float. Output of detector can be used with amplification to open a filling valve when the liquid in the tank falls below a predetermined level.

8. Radioactive materials such as radiocobalt can be used in place of radium and X-rays in making radiographic tests of casting walls and of welded structures. Since it can be machined to a desired shape and size before being made radioactive, radiocobalt affords a wider field of use in testing than does radium. Radiocobalt with total activities greater than are available in radium sources can be obtained at lower cost.

WHAT'S AHEAD IN *Mechanized*

Magnetic Fluid and Electromagnetic Clutches

Three years ago the National Bureau of Standards announced the development of the NBS Magnetic Fluid Clutch. Since then its unique features have been investigated extensively in both Government and industrial laboratories. Much information has been obtained on a number of problems including heat dissipation, settling of the magnetic powder, and hermetic sealing. The National Bureau of Standards has tested approximately 300 lubricating mixtures for use in the clutch.

The magnetic fluid clutch is based on the discovery that the frictional forces between solid surfaces and certain types of fluid media can be controlled by the application of magnetic fields. The simplest form of the clutch consists of two parallel magnetic plates separated by a powder composed of finely divided magnetic particles. When a magnetic field is established between the two plates, the magnetic particles bind the plates against movement parallel to their surfaces.

Magnetic clutches and brakes have been developed also in which a mixture of fine iron particles and a dry powder medium is "frozen" by a magnetic field to bond the driving and driven or braked members together.

Included in the advantages in these clutches and brakes are: Freedom from drag, long life of torque transmitting surfaces, torque at zero slip, automatic control of output speed or torque, constant or variable speed and torque output from constant or variable input speed, modulation of slip speed and accurately repeatable response in accordance with excitation, fast response to control current, small amount of power required for control compared with power output, adaptable for remote control operation, and dampening of torsional vibrations and chatter.

In these magnetic clutches, an electromagnet coil is integral with one rotating member, or with a stationary part surrounding a rotating assembly. A magnetic field, which is established when a current flows through the coil, solidifies the mixture of powder and iron particles that is present in or that is magnetically drawn into a small gap that separates the rotating driving and driven elements.

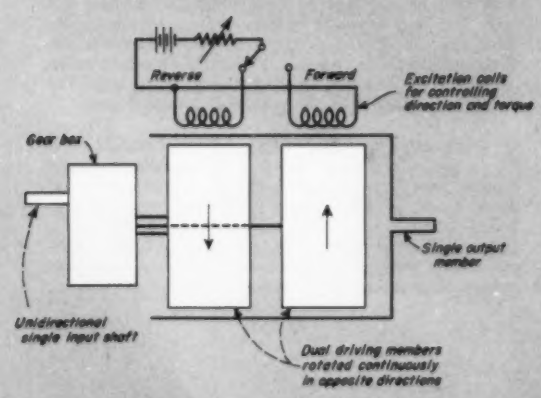
The solidified powdered mixture becomes a lubricated load-transmitting bond, the shear strength of which depends upon the composition of the powder mixture and the amount of exciting current applied to the magnet coil. By varying the proportions of the mixture and the exciting current, any condition between full slip to full lock-up can be obtained.

Since these devices have flat torque versus speed characteristics, the torque delivered is dependent almost entirely upon the coil current. A manually operated on-off switch, deflection of a spring, cable tension, speed, or position of a driven part of a machine can be used to control the coil current and thus regulate the output torque.

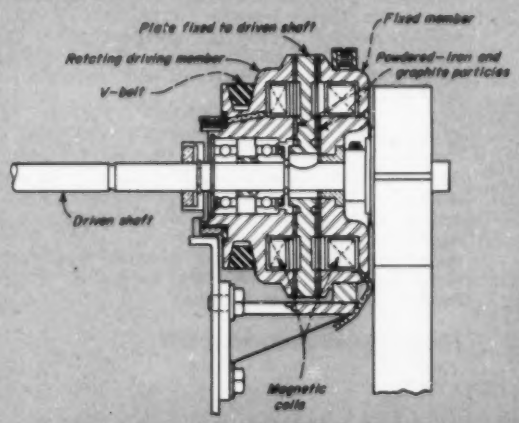
Any magnetic powder clutch can be used as a brake simply by restraining the rotation of one member. For applications where only one shaft extension is available for both driving and braking, brakes of sleeve mounting designs are employed.

Magnetic powder clutches have been designed with two driving members and associated excitation coils and only one driven member. The two driving members rotate continuously in opposite directions, and a simple reversing drive is achieved by switching in the excitation coil that controls the desired direction and torque. Because of the single low-inertia driven member, there is no backlash in the output shaft. In such a unidirectional input arrangement, the gearing employed to rotate the driving members in opposite directions is not limited to any particular ratio.

Schematic arrangement of a magnetic powder clutch for driving a single output member in either direction. A reversing drive is achieved by switching in the excitation coil that controls the desired direction and torque. Vickers Electric Division, Vickers Inc.



Combination clutch and brake plate is keyed to the driven shaft. Energizing the coil in the V-belt driven member engages and rotates the shaft. Energizing the coil in the fixed member brakes and stops the shaft. Eaton Manufacturing Company



Drives FOR MACHINES

Eddy Current Couplings and Brakes

Research and development work on eddy current couplings has resulted in the development of new magnetic pole forms of high efficiency.

The eddy current electric coupling has been applied chiefly in connection with furnishing variable speed when coupled directly to a standard a-c motor of either the synchronous or induction type.

Basically, all electric eddy current devices consist of two rotors, one operating inside of but not touching the other. Integral with one rotor are direct current field coils that when energized makes this rotor an electro-magnet that produces eddy currents in the other rotor. These eddy currents exert a pull between the two rotors. When transmitting torque, the amount of slippage between the two rotors is accurately controlled by varying the direct current applied to the field coils. Either rotor may be connected to the driving shaft or to the driven shaft.

Eddy current couplings consist of two rotating members concentrically mounted on anti-friction bearings so that either can rotate independently of the other. The outer member, which is usually the input unit, is a cylindrical drum supported by one or two spiders, one of which is secured to a power input shaft. The inner member, which is usually the output unit, consists of cast-steel field sections supported on a central hub casting. When the application requires an integral eddy current brake, the drum is used as the output member. A stationary housing over the outer member of the coupling prevents accidental contact with rotating parts.

A permanent magnet alternator is mounted at the output end of the coupling when speed control or speed indication is desired. The voltage of the alternator is fed to the control and serves as a sensitive governor in maintaining a desired output shaft speed.

The principal characteristic of the eddy current coupling is smooth starting and ease of speed control.

When used in combination with an electric motor, clutches of this type are designed to deliver from 150 to 250 percent of the normal full load motor torque.

The inherent torque curves of eddy current couplings are such that with fixed excitation an increase in slip is always attended by an increase in torque. By controlling the degree of excitation, the clutch can be caused to slip to any extent desired.

Eddy current clutches are built in both air cooled and water cooled types for the removal of heat from the armature, which results from power loss in slipping.

Typical installations of eddy current couplings include:

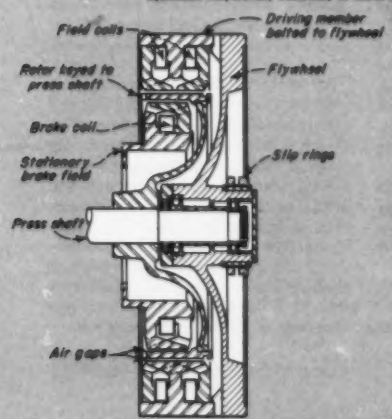
Windup drives in which the clutch torque is controlled and maintained to suit tension torque in winding or coiling fabric, strip metal, wire, paper and linoleum.

Fractional horsepower couplings and brakes for sewing machines, small fans, small pumps, and other machines and equipment driven by small a-c motors.

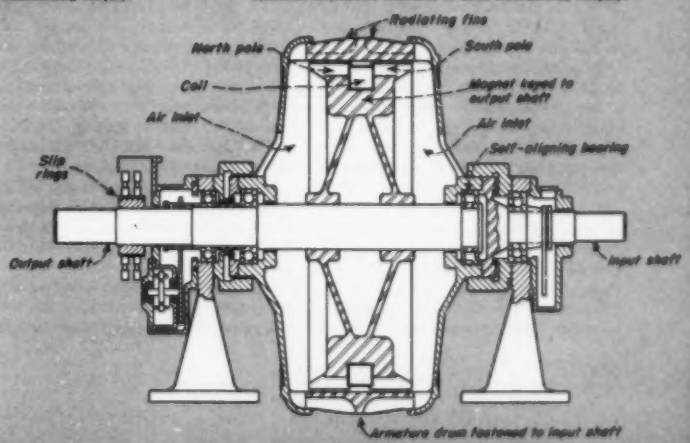
Electrically driven shovels, cranes, hoists and winches that operate on intermittent cycles and that start and stop quickly.

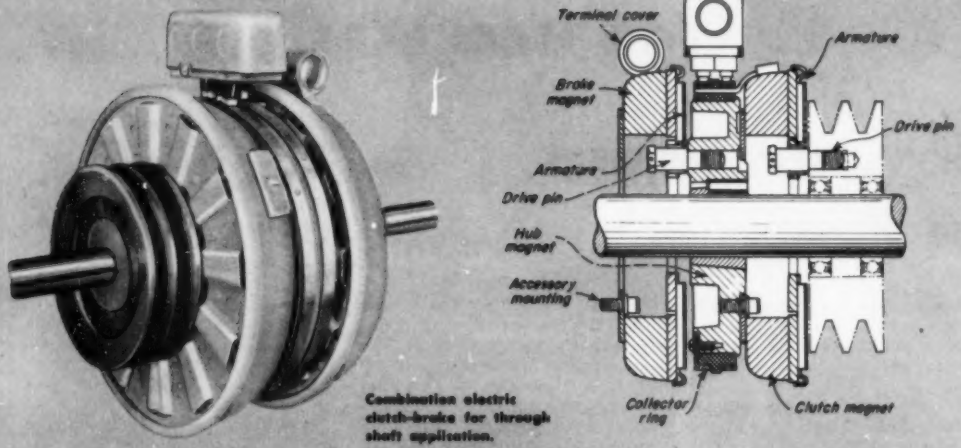
Punch press drives consisting of a coupling, brake and flywheel in one unit. With these drives it is not necessary to wait for mechanical parts to become aligned before the clutch will function. Power delivered by coupling can be controlled to suit the amount of energy required to overcome friction of the press and to apply a desired pressure during die setting and tryouts. With motor running at full speed, a control circuit reduces the clutch speed to a pre-selected speed for inching. Variable slide speed and variable slide torque during the work stroke can be obtained by adding an electronic unit to the punch press control.

Combination variable speed eddy current coupling and brake in punch press drive operate at any position of drive shaft.
Dynamatic Corporation, Subsidiary of Eaton Manufacturing Company.



Two pedestal type air cooled variable speed eddy current coupling or clutch. Rotor slippage is controlled by field current.
Dynamatic Corporation, Subsidiary of Eaton Manufacturing Company.





Combination electric clutch-brake for through shaft application.
Warner Electric Brake Manufacturing Company

Electric Brakes and Clutches

With the trend toward higher and higher production rates, machinery designers are now striving to reduce as much as possible the time required to change work pieces in a machine. Stopping and starting an entire machine to change work pieces is being avoided. Combination clutch and brake units are installed on machines so as to start and stop as few moving parts as possible while the driving motor runs continuously. Not only are production rates increased by reducing speed up and slow down times, but often smaller motors can be used because inertia loads are less.

Electric clutch units; electric brake units; and packaged electric clutch-brake units, which occupy much less axial space than that required for separate clutch and brake units; have been developed in answer to these demands. Brakes for direct mounting on NEMA "C" frames from size 203 to 365 are now also available.

Current designs of electric clutch or brake units consist essentially of a doughnut-shaped magnet, which contains an energizing coil, and a disk type segmental armature. The magnet receives direct current through collector rings and brushes.

As a brake, the magnet element is fastened to a stationary member or frame, and the armature is attached to the rotating member. As a clutch, both the magnet and armature rotate with the hubs or pulleys to which they are attached.

To set a brake or to engage a clutch, the magnet coil is energized causing the armature to be attracted to the magnet. Braking or clutching is then obtained by the armature coming in contact with the pole faces as well as with a molded friction lining between the pole faces. The brake or clutch being electrically set does not hold an overhauling load in the event of power failure. To release the brake or clutch, the magnet coil is deenergized. To speed the releasing and to minimize the residual magnetism, a fixed air gap is provided in the inner pole face.

In addition to compactness, these electrical units offer several advantages:

Application of torque is cushioned because the current requires about 0.1 sec to build up to full value at rated voltage. The unit operates quickly, however, because the mechanical movement required for engagement is extremely short. The time constant of the unit circuit can be reduced by adding resistance and raising the applied voltage.

The unit does not have to be adjusted to compensate for wear.

Running torque increases as the slip decreases and can be adjusted automatically or manually by varying the resistance in series with the unit.

Lack of thrust on any bearings from the operation of the unit.

Complete separation and lack of any adjustment between the two members if the clutch and brake combination is used.

New developments that are not yet available

Integral clutch-brake motors are being developed that will start and stop the drive shaft while the motor turns continuously.

New types of electric clutches that have no collector rings are under development. Such clutches will broaden the field of applications by including installations where the collector ring is a safety hazard or a maintenance problem.

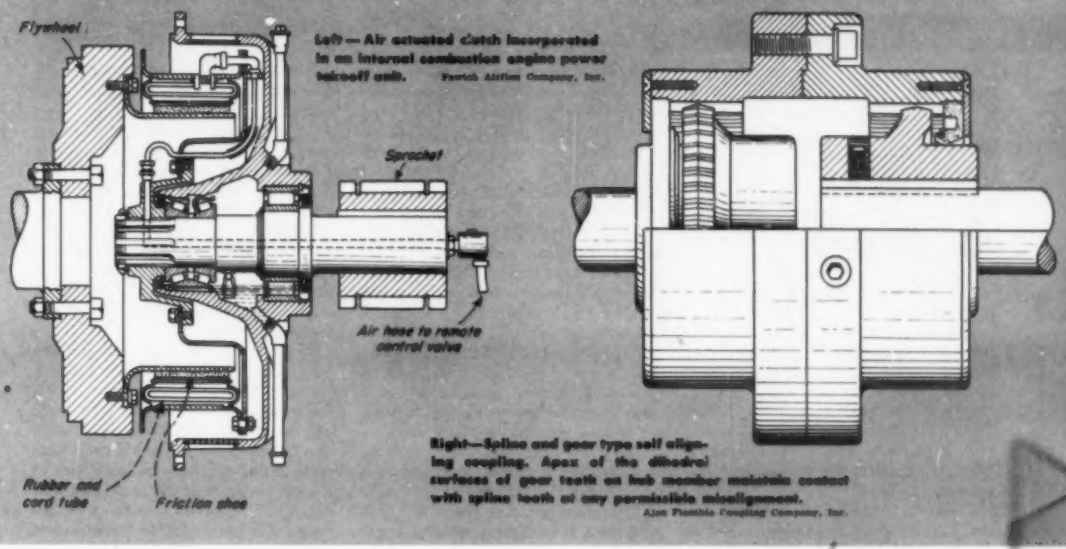
Oil immersed units are in progress of development to fill several needs that include highly stable torque variation with current, and extremely low wear rate for continuous slipping duty.

New control components are under development to meet the occasional need for extremely rapid action.

Electrically actuated multiple plate clutches for wet or dry service are under development to meet need for high torque capacity in limited space.

New applications

Electric clutches and brakes are being used on textile looms. The clutch disengages the driving motor from the parts to be stopped for loom servicing or in emergency, and the brake does the stopping. Advantages of this system of loom drive are: Protection rods, daggers and conventional shipping motion parts are not needed; push buttons replace shipper motion handles and linkages; less breakage of loom parts; and preposi-



Left — Air actuated clutch incorporated in an internal combustion engine power takeoff unit. Twitch Airflex Company, Inc.

Right—Spline and gear type self aligning coupling. Apex of the dihedral surfaces of gear teeth on hub member maintain contact with spline teeth at any permissible misalignment. Ajax Flexible Coupling Company, Inc.

tioned stops at time of warp or filler breakage or incorrect shuttle flight.

Three electric brakes are incorporated in a new high speed spindle driven beam warper; one on the presser roll, one on the main drive shaft, and one on the cross over roll.

Innumerable redesigns of motor driven machines in which the main drive motor is separated from the machine by a clutch so as to obtain more frequent starts and stops with smaller motors.

Hobbing machine drive with a constantly slipping brake to reduce backlash and thus minimize chatter marks on work piece and generally improve quality of production.

Slipping clutches used as tension controls and variable speed drives in material winding and unwinding.

Air Actuated Clutches and Brakes

Clutches and brakes actuated by an air inflated tube have been developed to keep pace with the improved construction of other power transmission components. In these units friction shoes, arranged cylindrically in a ring-shaped housing, are moved radially either inward or outward against the face of a drum by the expansion of an air inflated flexible flat rubber tube.

Admission and exhaust of air pressure in the tube, to engage and disengage the clutch or brake, are controlled by a small quick acting valve. Levers, fulcrums, sliding collars, springs or linkages are not needed to achieve clutching or braking.

In the released position, heat is dissipated through an air space between the friction shoes and the drum.

Compensation for operating wear of the friction blocks is automatically accomplished by the inherent resiliency of the tube, which is constructed of rubber and cord.

All torque load is carried through the flexible air filled tube. The cushioning action of the tube protects both the driving and driven members from load shocks, power peaks and vibration.

Variable axial thrusts are absorbed by the flexible walls of the rubber and cord tube.

Since the clutching or braking torque is applied at a maximum possible diameter over a full circumference of drum friction surface, the design for a required torque is compact. Therefore, the space needed for installation and mounting air tube clutches and brakes is small.

Applications for air tube actuated clutches and brakes include drives for: Blowers, compressors, conveyors, cranes, dynamometers, fans, hoists, mixers, paper mill machinery, pumps, punch presses, rubber mills, and power shovels.

Self-Aligning Couplings

Spline and gear type flexible or self aligning couplings have been designed to accommodate shaft misalignment either angular or offset, or a combination of both, up to a total of 7 deg with a minimum of clearance or backlash.

Teeth on the hub and the internal ring gear members are of the 30 deg involute spline form. The teeth on the hub member are full form at their mid width, but are uniformly reduced in thickness toward their ends. Thus at any permissible degree of misalignment, full contact is maintained between the apex of the inclined tooth surfaces of the hub member and the straight spline teeth of the ring gear. At maximum rated misalignment, the driving contact area spreads over the width of a half tooth.

Free end float in the coupling permits electrical machinery to find its magnetic center thus removing end thrust on bearings.

Positive oil seals in the coupling assembly retain lubricant.

Toothed Couplings

Curvic couplings have recently been developed for the connection of machine parts where high load capacity, accuracy, and ease of production are desired. In addition, complete interchangeability in the assembly of the coupled parts is assured when the teeth of these couplings are ground.

Three types of Curvic couplings are available to meet various design requirements: Permanent couplings, semi-universal couplings, and releasing couplings or clutches.

Permanent type couplings are used to join parts that require a combination of driving and alignment. This type is entirely self-centering and is used in built-up crankshafts, turbine rotors, camshafts and shafting requiring a precision connection. The teeth have straight-sided profiles, and a 30 deg pressure angle that has been found to provide accurate centering of the teeth with the best balance between maximum surface contact and least separating force.

An assembly of particular interest is shown in the accompanying figure. This high speed compressor rotor for an aircraft jet engine is assembled from individual disks in the hub faces of which Curvic coupling teeth have been ground.

Another interesting assembly is a built-up crankshaft for a radial aircraft engine. In this crankshaft, Curvic coupling teeth join the individual members permanently in correct alignment. This construction permits the use of solid connecting rod bearings.

The manufacture of both the compressor rotor and the crankshaft is facilitated by their designs that employ this precision coupling method on simple interchangeable parts.

The semi-universal type coupling is a flexible coupling that allows a slight angular misalignment of shafts together with axial freedom. This type has a zero degree pressure angle and is frequently used in the drive between an engine or motor and its transmission.

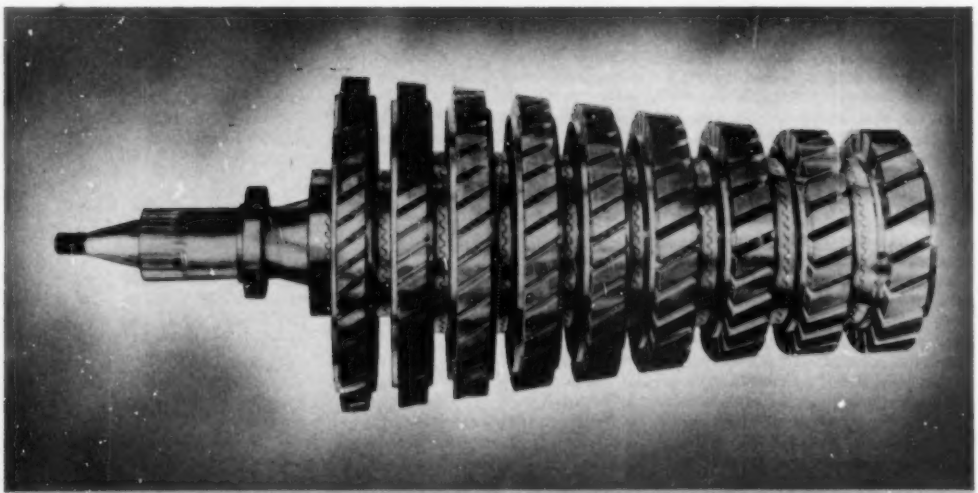
Releasing couplings can be made in a variety of tooth shapes to meet the particular requirements of a given design. Shift clutches and overload clutches are among the most common. The overload clutch is generally used with an electric safety interlock to limit the torque in power drives. The two members of the clutch are held in engagement by a spring. The amount of torque that can be transmitted without disengagement of the clutch is controlled by adjusting the spring tension. At a preset limit of clutch disengagement, the load is released by an electric switch.

Curvic coupling teeth are produced on special machines designed for the purpose. Both sides of the teeth are produced with the same arc of a circular face-mill type cutter or grinding wheel. Thus both sides of the teeth have the same curvature, either convex or concave and extend in a radial direction. This method of manufacture permits fast rate of production.

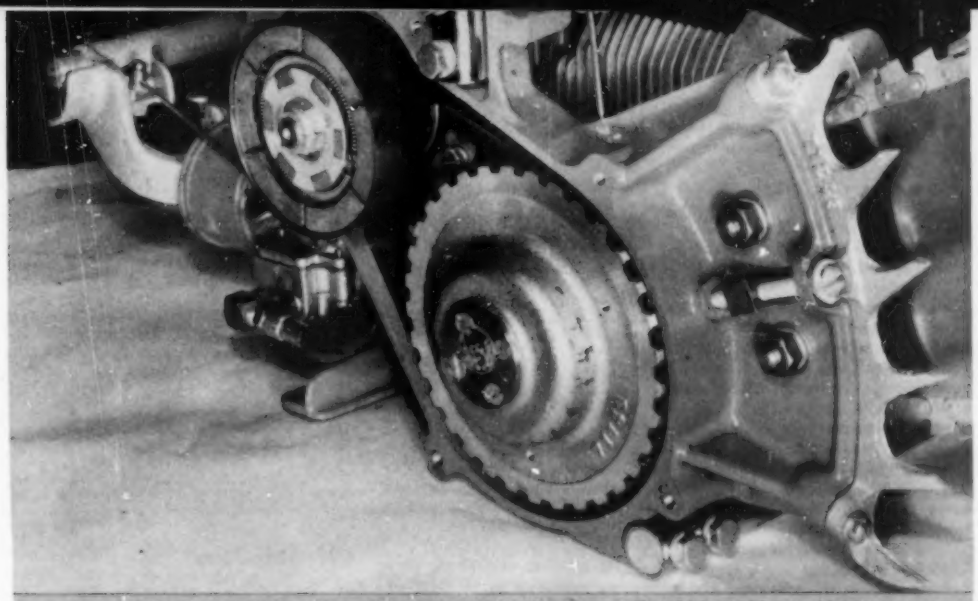
In most designs, convex teeth are used on one member and concave teeth on the other. When desirable, the amount of lengthwise curvature can be varied so that a localized area of contact occurs between mating teeth. The teeth can be produced in a wide range of pressure angles. The depth of the teeth is constant, which permits the chamfer to be produced in the same operation with the sides of the teeth.

To provide clearance for the cutter, there can be no projections beyond the root line on either side of the teeth. The face width of the coupling teeth, which is the width of the annular ring between outside and inside diameters, should be limited to 25 percent of the outside radius.

The Curvic design provides an accurate, light, compact, and self-contained connection in which the teeth both center and drive. It offers a simple and practical means of accurately joining two sections of a shaft for the transmission of power.



Compressor rotor for an aircraft turbine engine is assembled from individual precision disks. Curvic coupling teeth between each stage accurately center the separate members.
The Gleason Works



Belt with teeth drives 4 hp portable chain saw. Instantaneous stalls, which would probably break gear teeth, have no effect on the belt. No take-up adjustment is necessary.
United States Rubber Company

Positive Transmission Belt With Teeth

Endless rubber and fabric flat belts with regularly spaced teeth on one side are a recent outstanding development in power transmission belts. The teeth interlock with correspondingly spaced grooves in the faces of the driven and driving pulleys. The positive tooth and groove engagement of belt with the pulleys transmits power without slip, creep and speed variation.

Either of two materials are used as tension elements in the construction of these timing belts. Steel cable is used for most transmission drives. Cotton cord chemically treated is used for light drives. For special requirements, however, a number of special constructions have been developed. The body of the belt is a molded neoprene compound, except when Buna-N is used to withstand extreme heat and oil conditions.

Elastic and permanent stretch in service is negligible; with fixed pulley centers no take-up arrangements are necessary.

Flexibility of belt permits pulley diameters as small as ½ in. at 10,000 rpm. Under some conditions, speed ratios of 30 to 1 are practical. With these advantages, compact belt drives can be obtained.

Small drive dimensions make it possible to achieve low initial installation cost. Cost per horsepower decreases as the rated horsepower increases.

Maintenance costs are low since no attention is required to take-up stretch, and lubrication and dressing of belt are not needed. Oil, however, does not harm the belt.

Fundamental and basic development work has been completed, and belts of standard construction are being produced in any desired width and in a variety of materials to suit specific applications, yet there is much development work still to be accomplished.

Among the proposed development projects that appear to be desirable are:

HORSEPOWER RATINGS. Although horsepower ratings for stock drives have been established, they must be checked by running tests to include a service time factor. This program is currently under way on a small scale, which will be increased as production expands.

STRAIGHT RUNNING. To minimize sensitivity to misalignment, all factors that affect straight running are being investigated.

TENSION COMPONENTS. Preliminary investigation indicates that cord made of glass yarn is an excellent material for timing belts. Its comparable strength and stretch characteristics are about the same as those for steel wire. Another important property is that glass yarn is not affected by humidity.

NOISE. Compared to some other forms of flexible transmission components in their respective speed ranges, the timing belt is quiet. But further development can probably reduce some of the little noise produced at high speed ranges.

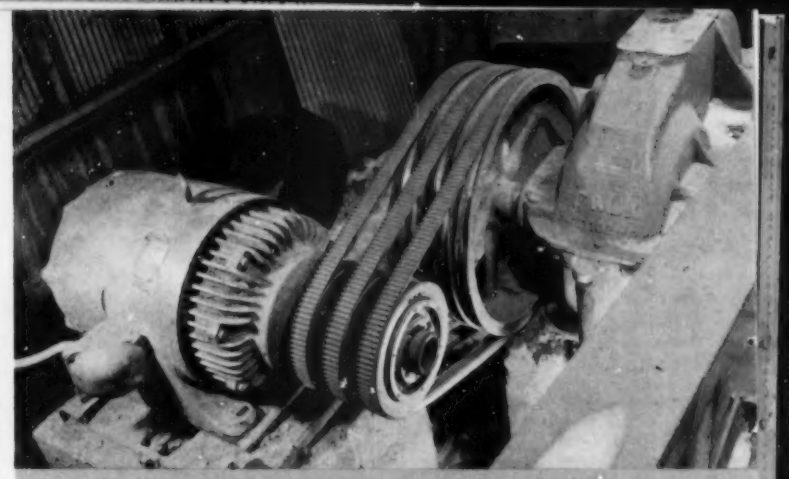
TOOTH FORM. Insofar as tooth form is concerned, development work is incomplete. While present tooth forms are satisfactory, they probably can be improved.

TEETH ON BOTH SIDES OF BELT. Inquiries indicate an appreciable demand for timing belts having teeth on both sides. With further research such belts could be developed.

NON-ENDLESS TIMING BELTS. Design and production on non-endless timing belts appear to present no particular problems, except for the time required for development.

All possible applications for the timing belt are not yet known because of the short time it has been in production.

V-Belt Drives



Three V-belts on a variable pitch sheave, with a range of 2 to 1, driven by motor on an adjustable base provides variation in conveyor speed.
Allis-Chalmers Manufacturing Company

High strength V-belts have been designed by all manufacturers that carry ratings of 40 percent greater than those of standard belts. The added strength has been built into the cord section only. In these high strength belts, the cord sections are steel wire cables, rayon, nylon, or chemically produced fibers. No changes have been made on cover stock, belt construction or rubber compositions to obtain this higher rating.

Applications for high strength belts include: Drives in which standard belts would require more space than is available; drives on which a large number of standard belts would be required making additional bearings or shaft extensions necessary to accommodate unusually wide sheaves; and drives where standard belts fail prematurely through error in original design, increased load or unknown peak loads.

New developments in V-belt drives have had a marked effect on sheave design. Variable speed sheaves have been developed that give mechanical speed ratios up to 3¾ to 1, and can be adjusted by merely turning a screw or hand wheel. Such units require no grease or oil to maintain efficiency and belt tension.

V-belt drives and variable speed V-belt drives are being used in almost every industry. In addition to drives for ventilating and heating equipment and for machine tools, V-belts are used on speed boats and in dredges to save space. They are used in mining machinery, saw mills, and rock and stone crushers, where heavy loads are encountered. The fruit harvesting and canning industries are large users of variable speed V-belt drives, because they stay clean.

On some farms, rotating machinery such as grinders, silo fillers, and hay cutters, which were formerly driven from power take-off drives of tractors, are now driven by 15 to 25 hp electric motors and V-belts. The motor is carried on a two-wheel truck so that it can be readily transported from one machine to another.

Chain Drives

Chain drives are compact power transmission arrangements for practically all horsepowers. Requiring only a small space along the shaft, chain drives can be operated over small sprockets at short centers with full efficiency. Center distances are not fixed by speed ratio requirements, thus simplifying the design.

Speed ratios can be changed by simply replacing one sprocket and lengthening or shortening the chain, or by using an adjustable take-up. Shaft centers need not be disturbed in changing the speed ratio.

Being a positive drive without slip, only the working strands of chain are subjected to tension, therefore, shaft bearing loads are low.

Initial tension is not needed, thus chain drives are easily installed.

Some interesting applications of roller chain include:

(a) Rotating simultaneously, at the same speed in opposite directions, two rows of friction rolls on a printing machine.

(b) Revolving an irregularly shaped form on a wood shaper. The chain is fastened to the base of the form by screws extending through attachment links. A feed sprocket engaging the chain revolves the form while it is held in constant contact with a collar on the cutter spindle by an air cylinder.

(c) Changing the speed of a cylinder shaft by using an adjustable take-up to permit the use of larger or smaller sprockets on an intermediate shaft to obtain a desired speed.

(d) To save space and to simplify driving arrangements in a paper bag making machine. Previously 7 driving gears and 7 idler gears were employed to drive 7 rollers that carry paper through the machine. By removing all 14 gears and the 7 idler shafts, and installing a sprocket on each roller shaft, the drive was converted to roller chain.

(e) To drive the rollers of a curved conveyor. The chain is curved around the conveyor with the curvature across the width of the chain strand. To keep the chain in mesh with the sprockets on the ends of the rollers, idler sprockets are installed between every two roller sprockets.

(f) To obtain flexing in any of four directions, a coal loader conveyor chain is assembled with a universal joint. This special construction permits the rear conveyor to be moved up or down 45 deg, and to be moved 45 deg to the right or left.

New Developments

A revolutionary new power transmission drive will soon be announced. Its unique design characteristics remove many of the limitations to which conventional chain drives are subject.

This new drive was designed with the sole objective of obtaining maximum load carrying ability at both low and high speeds.

It makes possible: Single drives capable of transmitting up to 5,000 hp; linear velocities as high as 6,500 fpm; and up to 3,600 rpm rotative speeds.

Variable Speed Drives

A significant trend in the application of mechanical variable speed units is the growing recognition of their utility and dependability in driving machines and equipment that produce a wide range of products.

Designers are also aware of the convenient and economical changeovers that are made possible by variable speed drives when machines are required to manufacture or process products other than those anticipated when the machine was designed.

In many types of machines, design improvements have increased their productive capacity to a point where it frequently exceeds production demands. Proper utilization of such machines, especially bottling, filling, cartoning, or packaging machinery, requires that a desired speed be quickly obtainable to accommodate any one of a wide range of sizes, shapes, or weights of the package.

Increased machine utilization with variable speed drives is being achieved in many applications, which include machine tools, punch presses, heat-treating furnaces, baking and drying ovens, and food processing equipment.

Stepless continuous speed change is advantageous in the control of tension or velocity of cloth, paper, metal, and other materials that are being wound or unwound on coilers, reels, drums, and rolls.

Close control of speed is often required to maintain desired quality with maximum production of materials that have varying characteristics. Variations in quality of paint, thickness of paint coats, complexity of the shape of objects painted, or atmospheric conditions may require changes in time of passage through a drying oven. Variations in metal composition may require changes in the time a part is in a heating-treating furnace.

The availability of a number of different types of control for variable speed drive units have increased the applications of these drives in all industries. Types of control include handwheels; levers; mechanical and electrical remote control devices; and automatic mechanical, hydraulic, pneumatic, and electronic controls.

A variable speed pulley for driving light machines has been developed for direct mounting on the shaft extension of an electric motor, which is fastened to a sliding base. The V-Pulley consists of two tapered disks that telescope into each other. The disks are held together by spring pressure. A standard V-belt is used between the V-pulley and the driven pulley. Movement of the motor backward or forward increases or decreases the tension in the V-belt, thus allowing the disks to spread apart or to close together so that the belt runs on a smaller or larger diameter of the driving pulley.

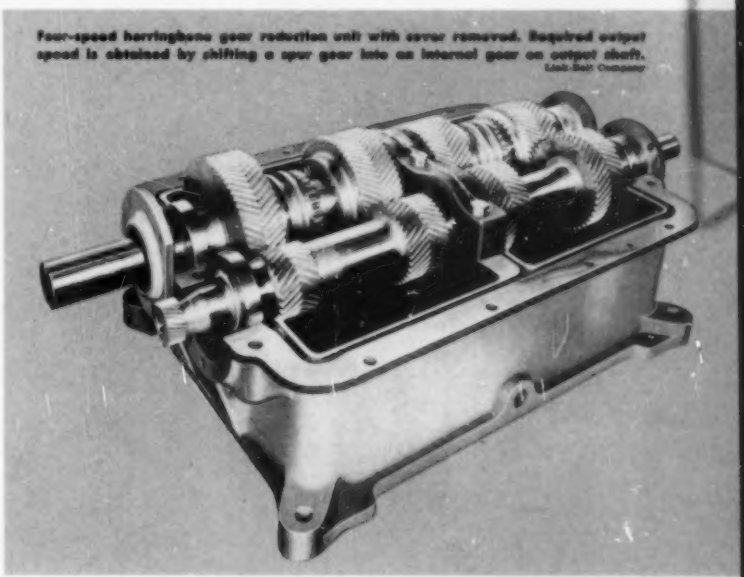
Gear Reduction Drive Units

Almost every standard or special drive requirement can be met from the large range of herringbone, helical and worm gear reduction drive units now available in many speed ratios and compact constructions. Precision generated and finished teeth in gears of the single, double, or triple reduction units result in accurate, vibration free and quiet operation.

Gear reduction units are being used for transmitting power from electric motors, steam turbines, gas and diesel engines; and for driving conveyors, line shafts, generators, blowers, machine tools, screens, cranes, hoists, agitators, bleachers and many other types of industrial equipment.

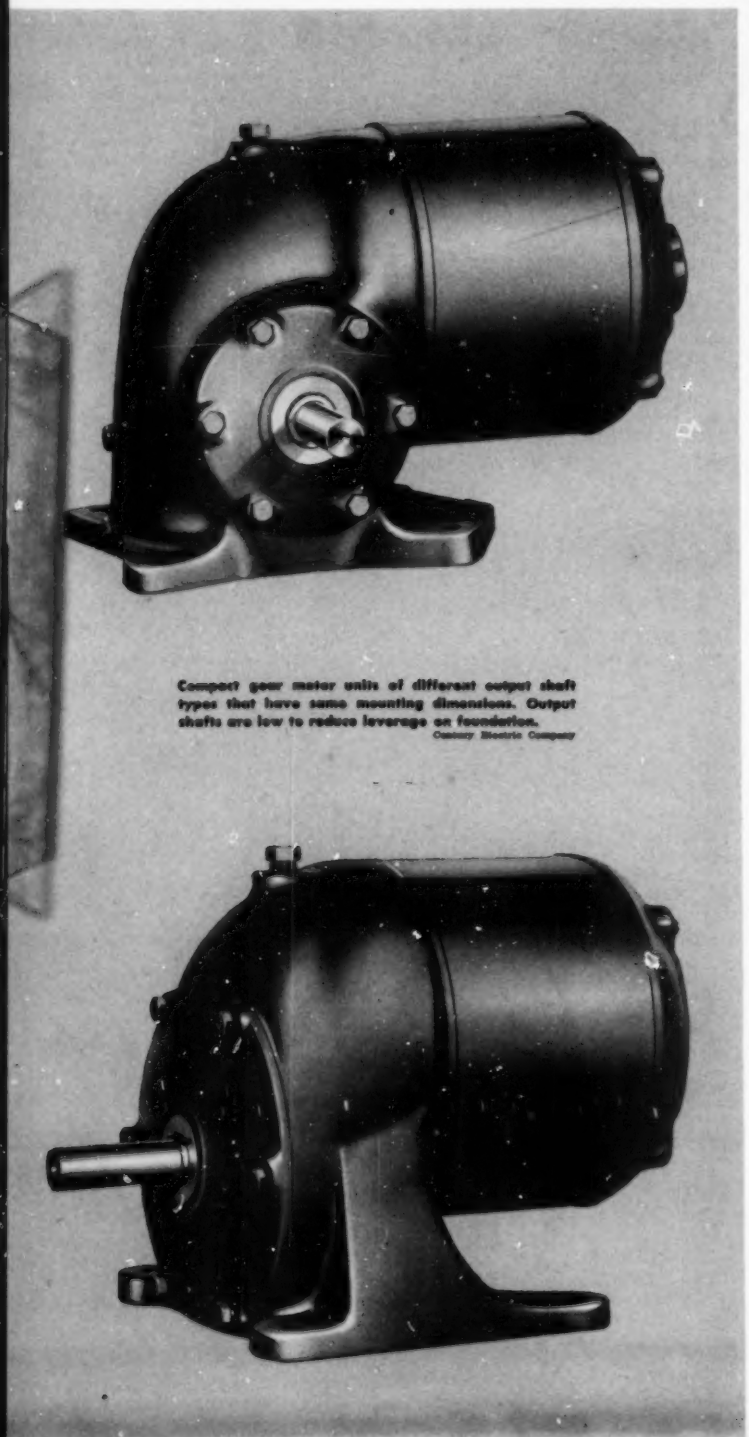
Multi-speed herringbone gear reducers have been designed to deliver one of two or more output speeds. These are being used where two or more optional constant driving speeds are required, and where multi-speed motors only cannot be used. In combination with multi-speed motors, the multi-speed gear reducer offers a drive arrangement from which a wide range of speeds is obtainable. Speed changes are made only when the unit is not in motion. Speed changes are made by operating a shifting lever extending from the top or side of the reducer housing. For pressure lubrication, the unit is equipped with an oil pump and oil cooler.

For machine drives that require many output speeds, the desired reduction speed ratios can be obtained by compounding several gear sets in a multiple arrangement between the service of power and the output shaft.



Four-speed herringbone gear reduction unit with cover removed. Required output speed is obtained by shifting a spur gear into an internal gear on output shaft.
Link-Belt Company

Gear Motors



Compact gear motor units of different output shaft types that have same mounting dimensions. Output shafts are low to reduce leverage on foundation.
Century Electric Company

Many improvements have been achieved in the design and construction of gear motors and motor driven speed reducer units. Recent designs are conspicuous for their long life, compactness, quiet operation, stiff construction, high efficiency, oil tight construction, dependable lubrication, freedom from adjustments after installation, and easy maintenance.

Designs of motor and gear case have become more compact and streamlined. The degree of compactness increases as the gear ratio increases. Compactness enables the motor and gear case to be cooled with the same system. This advantage is important where the heat of worm gears is to be dissipated. The streamlined designs can be readily kept clean. When mounted in an exposed position, streamlined gear motors add to the attractive appearance of the machine.

Standard NEMA gear motor speeds advance in small increments, each speed is approximately 22½ percent more than the next lower speed. Thus a wide selection of speeds is available for the driven machine.

Gear motors are now built with the same mounting dimensions for a large range of horsepowers and speeds. The foundation size and number of bolts are usually no larger for a gear motor than those required for the motor only. These features are advantageous when designing a group of similar machines.

Gear motors now being produced can be mounted in the several conventional mounting positions without reassembling or the need for extra parts.

Output shafts are lower. The combination of torque and lower shaft height produces less leverage to pry the gear motor from its foundation. This factor is important where the output speed is low and the output torque is high.

Many gear motors now fit snugly to their foundations leaving no cracks for the entry of dirt and other contaminations. This feature is of special importance where foods and chemicals are processed.

Synthetic compounds are now used to seal all gear case joints. No trace of oil film appears on the outside to collect dust. This practice, together with modern oil seals, practically removes the hazard of oil contaminating the processed material.

Built to hold a large quantity of lubricant, gear motors now require a minimum of attention and servicing.

Steel housings and frames and cast iron housings and frames, are being

used to inclose motor driven speed reducer units. Built for vertical, horizontal and right angle mounting, these units are available either with an extended base for supporting a separately mounted coupling connected foot type motor, or with arrangements for integrally mounting a flanged type motor.

Fluid Drives

The constantly increasing use of fluid drives in automobiles, buses, trucks and tractors indicates that this method of transmitting and controlling power has many advantages. These advantages can be successfully and profitably applied to many kinds of industrial machines.

Fluid drives transmit power hydrodynamically by utilizing the kinetic energy of the mass and velocity of a fluid. Their performance characteristics are inherently smooth starting and acceleration; power output without shock, impact and torsional vibration; prevention of overloads; uniform and smooth operation; and simplicity of drive arrangements.

Whether this type of transmission is designed as a drive, a clutch, a brake, or a coupling the principles of operation are fundamentally the same.

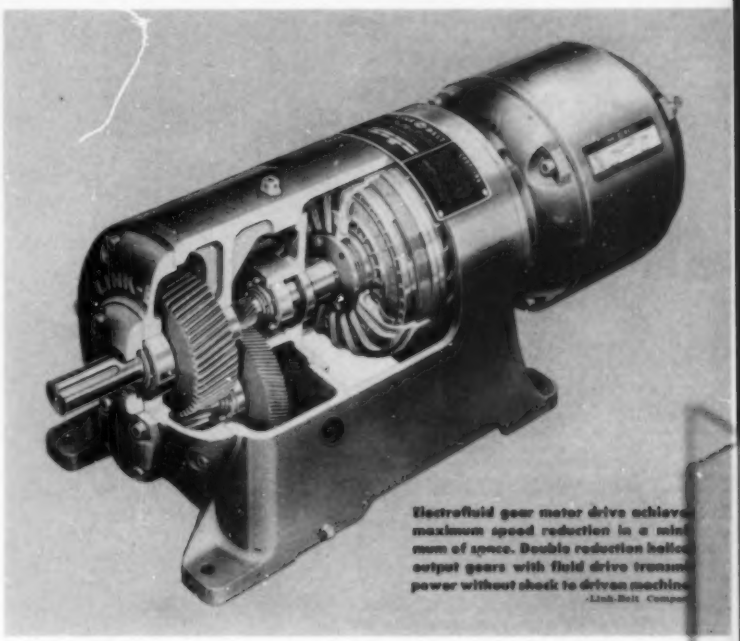
In fluid transmissions, there is no mechanical connection for transmitting power from the prime mover to the driven machine. The unit consists of two main parts:—an impeller connected to the prime mover, and a runner or reactor connected to the driven machine. The space between these two elements is usually filled with a light mineral oil.

Rotation of the impeller buckets by the prime mover imparts high rotational and centrifugal velocity to the oil. The resulting circulation of the oil into and against the runner buckets develops a torque in the runner equal to the torque delivered to the impeller.

Since the drive is not positive through the fluid connections, a flexibility of power application is obtained that is an advantage in many machine drives.

Speed difference or slip between impeller and runner varies with the amount of oil in the coupling and the inertia of the applied load. Reducing the amount of oil in the unit increases the amount of full-load slip.

In a motor drive using a fluid coupling, the motor starts unloaded. During acceleration, the motor is smoothly and gradually loaded. With a heavy inertia load, the motor approaches the speed of its maximum torque before the output shaft begins to revolve. This characteristic provides a break away torque that, without a fluid drive, would often require an oversized or special type motor.



Electrofluid gear motor drive achieves maximum speed reduction in a minimum of space. Double reduction helical output gears with fluid drive transmit power without shock to driven machine. —Link-Belt Company

Hydraulic couplings permit an electric motor to accelerate rapidly out of the low speed region of operation in which high current is drawn. Hence the amount of special motor starting equipment necessary is reduced. If the coupling is properly selected, the motor speed will rise rapidly to a point near maximum torque conditions. Thereafter, the speed of the load will increase rapidly until it approaches motor speed, when the slip decreases to a minimum.

Prevention of machine overloading is an important advantage of fluid couplings. Oil in the coupling can be reduced to the minimum required to start a normal load and bring it up to speed. If motor torque is insufficient to start an overload, the motor will slow down until it develops its maximum torque. The motor will continue to run at this speed with no movement of the load shaft, and the machine connected to the runner will not be subjected to more than the preset normal torque.

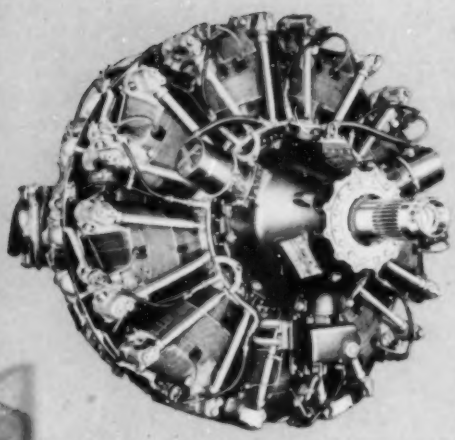
With the motor running and the driven machine stalled by an overload, the coupling would soon overheat. An overload current control relay in the motor circuit, however, would quickly trip to stop the motor. One method of reducing drag torque with the runner stalled is to dump part of the oil out of the circuit into an external reservoir by automatic or manual means.

Load and speed variations are reduced because of the equalizing and shock absorbing ability of the coupling.

Freedom from shock to the load and motor provided by a fluid drive permits reversal of the motor from full speed forward to full speed reverse without exceeding the torque capacity of the fluid drive.

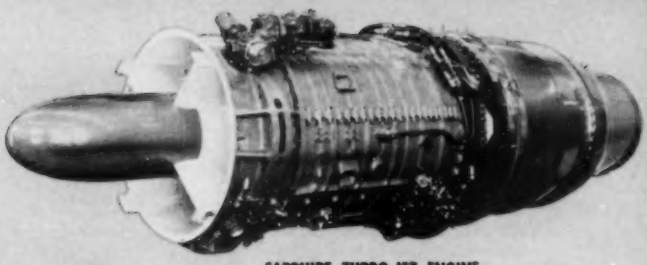
Inclosed fluid drives are available in many compact forms. Types with integrally mounted motors are built with mounting and shaft dimensions interchangeable with corresponding sizes of NEMA frame motors. In another type without motor, an input shaft is provided that can be direct coupled, belt or chain driven from a motor or other source of power.

Compact combinations of fluid drives and speed reduction gear trains are built with integrally mounted motors, or with input shafts for other direct coupled driving sources. Output shafts can be direct coupled, or arranged for connection to a chain or belt take-off.

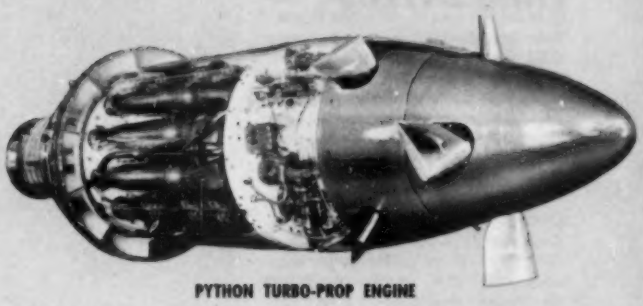


TURBO-CYCLONE 18 ENGINE

Wright Aeronautical Corporation



SAPPHIRE TURBO-JET ENGINE



PYTHON TURBO-PROP ENGINE

Aircraft Power Plants

In the last decade, the design developments in reciprocating engines, turbo-propeller engines, turbo-jet engines, ram jets, and rockets have made possible many outstanding advances in aircraft design and performance.

Rocket powered craft capable of traveling outside the atmosphere at speeds of 3,000 mph or faster are now a possibility.

Ram jet powered craft are expected to travel at 1500 to 3,000 mph. Within their proper speed range, ram jets are roughly five times as efficient as ballistic rockets.

Turbo-jet planes are flying at speeds up to 1500 miles per hour.

The many variable economic and service factors associated with aircraft operation make it difficult to evaluate the several types of aircraft power plants on any rational basis. Generally, the use of each type is dictated by specific requirements such as flight range, take-off and flight speed, flight altitude, desirability of quick acceleration in flight, cost of fuel per flight, and maintenance costs.

Compound piston engines are more versatile than uncompounded piston engines and probably will continue to power transport planes for some time to come. Compound engines excel in range and fuel economy; however, there is a horsepower limit below which it is no longer economical to apply compounding.

Steady improvement has been made in the design of piston engines to increase power output per pound of engine weight. Aircraft engines some years ago reached and surpassed the one pound per horsepower ratio. The Turbo-Cyclone 18, a compound engine, develops 3,500 hp with a displacement of only 3,350 cu in. displacement. It is the first aircooled engine to surpass the 1 hp or 1 cu in. ratio, although inline engines have also done so.

For aircraft operation at speeds less than 500 mph, the reciprocating engine of today has the advantage of being able to fly with 20 to 40 percent less fuel consumption at optimum cruising conditions than existing turbo-propeller and turbo-jet engines. At speeds from 350 to 400 mph, turbo-props require 50 percent more fuel than compound engines. At speeds from 400 to 500 mph, turbo-jets require 30 to 60 percent more fuel than turbo-props.

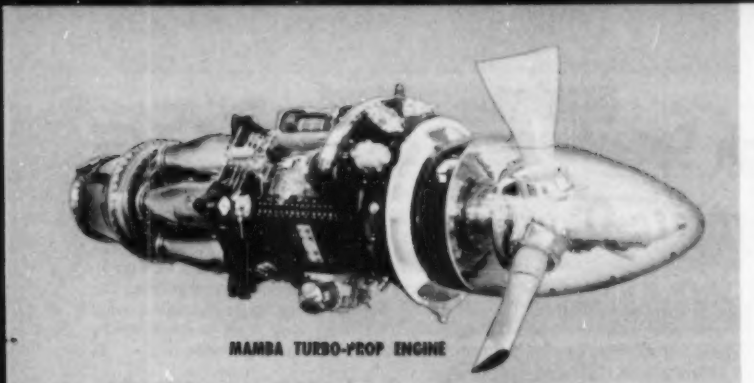
For the near future, therefore, it appears that much will depend on the discovery of better materials, development of new design principles, or cheaper fuels before jet engines can power transports over long distances as economically as can reciprocating engines.

At present, of course, if very high speed operation is required and economy is not an important consideration, the reciprocating engine affords no benefits that cannot be better obtained by turbo-propeller, turbo-jet, ramjet, or rocket power plants.

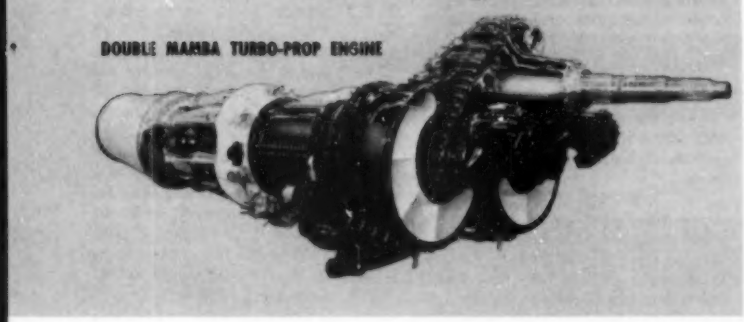
The in-flight power output of the larger turbo-jet engines is at present three to five times that of the largest piston engine propeller drives. Installed weight of the jet engine, on the average, is less than one fourth that of a piston engine of comparable in-flight power.

Despite this remarkable progress, turbine power plants of still higher horsepower rating are in demand to permit aircraft, both military and commercial, to fly at still higher altitudes, and to operate through wider variations in air temperature.

Performance data covering efficiency, weight, and thrust per unit of frontal area have not yet been released on all of the recent turbo-engines. Results of current research work, however, hold promise of achieving power plants with higher output, better performance, and improved reliability.



MAMBA TURBO-PROP ENGINE



DOUBLE MAMBA TURBO-PROP ENGINE

Much research and development work is being conducted to improve the design, to obtain lower fuel consumption, and to reduce weight and cost of the compressor. Component design is being refined. Compressor ratios are being increased. New designs of bearings are being investigated. New alloys are constantly being studied for their strength, creep, fatigue, thermal shock, and corrosion properties at high temperatures. New lubricants are being developed to meet extreme temperature and speed conditions.

A large part of the progress achieved in the performance of turbo-engines results from the improved properties of high temperature alloys, which can be cast and forged. Blade materials have been developed that possess high creep resistance and fatigue strength at high temperatures.

Several materials of the Stellite family and Vitallium have been used for producing blading by precision investment casting techniques.

Disk materials are available that have high strength at moderately high temperatures.

For jet parts that operate at temperatures up to 800 or 1000 F, further research on titanium alloys may yield a satisfactory material.

Titanium, because of its low density and exceptional corrosion resistance, promises to be important at some future time as a material that can be utilized to advantage in rotating engine members. Although the melting point of titanium is only slightly above that of chromium, a practical technique for melting and casting titanium is needed that must be developed to cope with its reactivity with hydrogen, nitrogen, oxygen and other non-metallic elements at high temperatures.

SAPPHIRE TURBO-JET ENGINE. The Sapphire is a straight-through turbo-jet engine, with an axial flow compressor and an annular combustion chamber of the vaporizing type.

While all other performance data are still classified, it has been disclosed that the Sapphire has successfully completed the 150 hr service type test at 7200 lb rated static thrust at sea level. With a cruise specific fuel consumption of 0.83 lb per hr per lb, it is helping to solve the problem of high fuel consumption, which so far has limited the range and endurance of jet aircraft.

Dimensions of the Sapphire are: Diameter over combustion chamber, 37.5 in.; diameter over trunnion mounting 42.2 in.; length from front flange to nozzle attaching flange, 116.12 in.; jet pipe diameter over heat shroud, 24.5 in.; and basic frontal area, 7.7 sq ft. Thrust is 935 lb per sq ft of frontal area, and the weight is 2569 lb net dry including accessories.

PYTHON TURBO-PROP ENGINE. The Python is a propeller turbine engine with a fourteen stage axial flow compressor, eleven combustion chambers of the vaporizing type, and a two-stage turbine. The reduction gear is arranged for contra-rotating propellers. The air system is of the reverse flow design with the intake well back from the spinner.

Dimensions of the Python are: Maximum diameter, 54.5 in.; and overall length excluding prop shaft but including tail cone, 122.77 in. Reduction gear ratio is 7.4 to 1. With a take-off 8000 rpm at sea level and 4550 equivalent shaft horsepower, the cruise specific fuel consumption is 0.506 lb per equivalent shaft horsepower per hour. The weight is 3485 lb net dry.

MAMBA TURBO-PROP ENGINE. The Mamba propeller turbine engine comprises a ten stage axial flow compressor that, with a two stage twin disk turbine and reduction gear drive shaft, forms a single rotating assembly. Air is fed straight through an annular intake, immediately behind the spinner, to six combustion chambers of the pre-vaporizing type.

Dimensions of the Mamba are: Maximum diameter, 29.0 in.; and overall length excluding prop shaft but including tail cone, 79.83 in. Reduction gear ratio is 8.80 to 1, or 10.80 to 1, or 11.85 to 1. With a take-off 15,000 rpm at sea level and 1480 equivalent shaft horsepower, the cruise specific fuel consumption is 0.65 lb per equivalent shaft horsepower per hour. The weight is 770 lb dry.

DOUBLE MAMBA TURBO-PROP ENGINE. The double Mamba consists primarily of two standard Mamba turbo-prop engines mounted side by side. The two units are coupled through a reduction gearing system to two co-axial contra-rotating propeller shafts, which operate independently of each other. The two engines have a common straight through type air intake placed just aft of the spinner. Each engine has its own fuel, lubrication and control systems for independent operation.

Dimensions of the Double Mamba are: Overall length excluding prop shaft but including tail cone, 102 in.; overall width, 52.3 in.; and overall height, 43.85 in. Reduction gear ratio is 10.37 to 1. With a normal 15,000 rpm at sea level and 2873 equivalent shaft horsepower, the cruise specific fuel consumption is 0.65 lb per equivalent shaft horsepower per hour. The weight is 2000 lb dry.

Bearings for High Speed and High Temperature Operation

With increasing speeds and rising temperatures, the factors in bearing design assume greater importance and require special consideration. The rapidly expanding gas turbine industry is largely responsible for the pressing need for further improvements in bearings. In these applications, there has been a trend toward the anti-friction type and much of the research work has been in this category. One reason is the lower starting friction of ball and roller bearings, particularly in cold weather.

Anti-friction Bearings

Under normal operating speeds, bearings are rated on the basis of the endurance limit of the inner race. With higher velocities, the centrifugal force acting on the balls increases the contact stresses on the outer race. Thus at high speeds, the outer race becomes one of the critical elements. The ball retainer or separator is also an important component; it must not become distorted under centrifugal loads and jam the rolling elements. At the same time, it is subjected to sliding friction between the high speed balls or rollers. Solidly preloaded bearings are to be avoided, since at high speeds any slight change or variations in preload will have a detrimental effect on performance. The problem of lubrication and lubricants for high temperature operation is extremely important and much development remains to be done.

Load and Speed Ratings: At present there is no method of rating bearings which is entirely satisfactory for extreme conditions of speed or temperature. One method used for high speed operation considers the dn value of the application: where d is the bore size (in mm) and n is the rpm of the inner race. This approach is approximate since the peripheral velocity of the inner race groove is the important factor and not the bore dimension. Small bearings with dn values of one million are common. However in special applications of short duration, bearings have successfully operated as high as dn of 1.7 million. This factor is illustrated in Fig. 1.

Another method of calculating the life of these bearings is based on the magnitude and frequency of load cycles on the outer race. This applies to instances where the speed is sufficiently high to make the stresses on the outer race higher than those of the inner race. This method utilizes the vast amount of fatigue data which has been accumulated on failures of both the inner and outer races.

For operation at temperatures above 300 F, the rating of conventional bearings (SAE 52100 steel) are reduced to compensate for the appreciable drop in hardness which has a decided effect on the life and load capacity. For moderately high temperatures, using stainless steels requires a large sacrifice in the rating at ordinary temperatures and a further decrease at higher temperatures.

ACCURACY is one extremely important factor in high speed applications; eccentricity, out-of-squareness, lack of parallelism, and ball-out-roundness can result in serious unbalance, heat generation, and similar destructive conditions. Such applications usually require precision grade bearings: ABEC-5 or higher. To minimize the possibility of premature failure, several companies dimensionally re-examine each bearing prior to its use in an assembly.

Using a shaft as an inner bearing race serves not only to reduce the effective diameter (and the dn value) but to also reduce the dimensional tolerances. Such a bearing is shown in Fig. 2. Balance of high speed assemblies is extremely critical; a particular rotating element at 100,000 rpm required a dynamic balance of approximately 0.0001 in. oz. To avoid unbalance due to reassembly, many machines are designed with an enveloping housing which can be put together around a previously balanced rotating assembly.

BASIC TYPES of bearings for high speed operation are either the angular contact or the deep-groove single-row (non-filling slot) radial bearings. The latter has less thrust capacity and requires a two-piece separator which has less strength and is more costly. However, this bearing has no low shoulder to contact which might possibly damage the balls. Special types have come into limited use as shown in Fig. 3: (A) the snap or low shoulder on the inner ring and (B) split inner ring. This split ring type is used where thrust loads predominate.

THE MOUNTING plays an important part in the performance of high speed bearings. Solid preloading is to be avoided, for local heating can cause appreciable preloading which may become dangerous. The geometry of bearing supports should be carefully examined to insure that a temperature differential, which often occurs during starting, will not distort the races. Opposed mounted, spring-preloaded bearings is a popular arrangement where one bearing is fixed in the housing and the other floats. This type is illustrated in Fig. 4 and the uniform spring preloading compensates for any slight variations in the internal fit-up caused by manufacturing tolerances or temperature gradients.

BEARING MATERIAL commonly used is the SAE 52100 alloy steel. For operation at temperatures above 300 F, this alloy exhibits an appreciable drop in hardness. In addition, during prolonged periods at high temperatures, it is dimensionally unstable which may cause serious changes in the internal clearances especially on large bearings. A modified 52100 steel has proven satisfactory up to 550 F but for higher temperatures other materials are required. High-speed steels, Stellite and various metallic carbides of tungsten and titanium which retain their hardness at elevated temperatures show promise; these materials are stable but have lower load capacity. Unfortunately, there is little data available concerning their performance as bearing materials.

SEPARATORS are generally the most critical component. One of the problems is the sliding friction which exists between the rolling elements and the separator; this becomes serious under the relatively poor lubricating conditions. These components must also resist the alternating forces due to variations in the velocity of the balls and also the high centrifugal stresses.

Up to 300 F, the non-metallic phe-

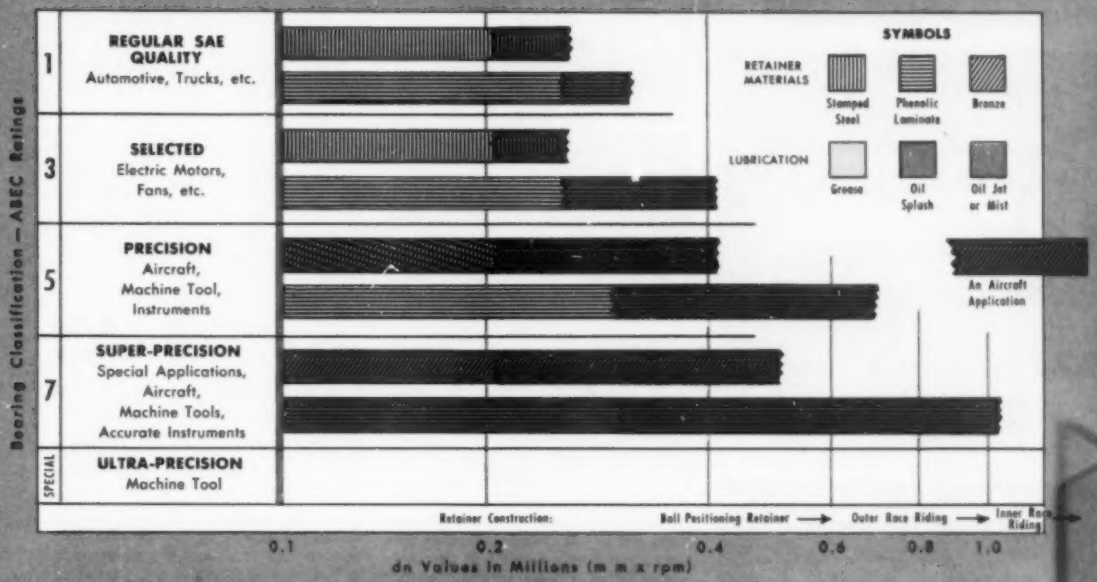


Fig. 1 — One criteria for high speed operation is the dn rating. Ultra and super precision bearings are most necessary in grinding spindles where the resultant finish is important. As shown above and with proper balancing, ABEC 5 bearings can be used for extreme speeds. They are cheaper and more readily available.

nolic laminates are excellent; developments in high temperature resins with laminated asbestos or fiber glass indicate the possibility of 400 F operation for this type.

Work is being done on combination materials such as silver plated, machined bronze or Monel separators as well as bonded bimetallic materials. Inner-race positioning or land riding separators shows greatest promise since creep or elastic deformations do not reduce the necessarily close clearances. This type is shown in Fig. 3 (C).

LUBRICATION serves primarily to provide a film at the points of sliding contact on the separator and also as a heat-transfer medium. Greases are occasionally used in high speed applications but only for cases of short duration and where the peripheral speed of the inner race groove does not exceed 10,000 fpm. Grease is not a good heat transfer medium and high centrifugal forces prevent adequate replenishment of the lubricant to the sliding surfaces.

Use of oil lubrication is most common. However, the method of application differs. Some devices use an oil-mist wick, as shown in Fig. 5. For small units and where simplicity is essential, this system is satisfactory. Fig. 4 shows the details of an air-oil mist application which is frequently used where temperatures are not too high and pressure air is available. For larger units, there is a trend toward the solid jet system as shown in Fig. 6 which has better heat dissipation qualities. For this jet to be most effective, it should be directed toward the inner race.

As a lubricant, high grade mineral oils have proven satisfactory except for applications where extreme temperatures are prevalent. In some cases synthetic lubricants have performed well. However, due to the wide operating temperature range of some applications, the use of dry lubrication has been found necessary. Considerable research work is being done on the coating or impregnating bearing surfaces with such substances as graphite, molybdenum disulphide, and boron nitride.

Journal Bearings

Research into improved bearing materials is a continuing process. At present most effort is being directed toward finding substitutes for strategic materials such as tin, lead and copper. In one instance, replacing tin with lead in a babbitt material was found to result in equally good bearing qualities.

In the automotive field, the anticipated bearing loads are continually

Fig. 2—To reduce peripheral speeds, high speed bearings should be made small. Using an integral shaft and inner race eliminates certain dimensional tolerances.

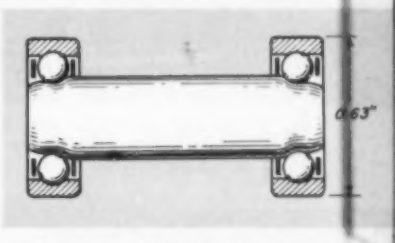
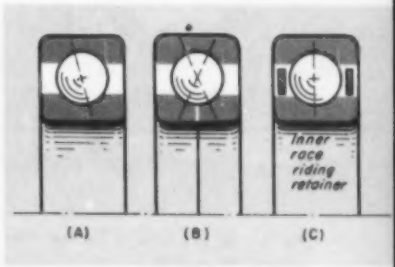


Fig. 3 — Construction details of common types of bearings used for high speed operation. (A) Angular contact type with an inner snap ring is used for radial loads; (B) split inner ring is for applications of high thrust forces; (C) inner race-riding ball-retainer shows promise at high speeds.



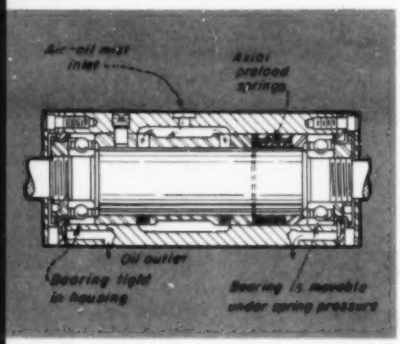


Fig. 4 — Use of springs to preload a bearing assembly prevents overloading due to thermal expansion.

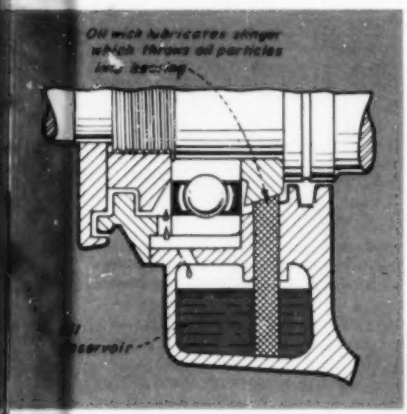


Fig. 5 — Oil-wick and slinger make a simple device to provide a mist for lubricating all bearing surfaces.

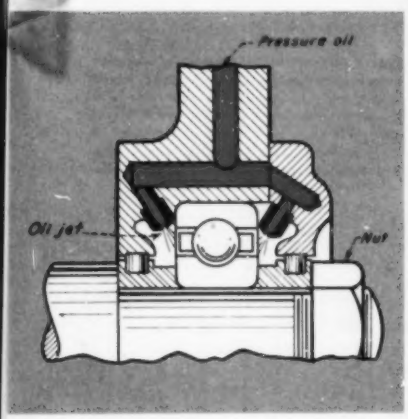


Fig. 6 — Oil jets serve to not only lubricate but also provide an important cooling medium for high speed bearings.

increasing. This is due to the trend towards: (1) higher compression ratios for better fuel economy; (2) increased bore to stroke ratio for greater valve area and lower piston speeds; and (3) shorter engine lengths for improved rigidity and smoother operation. These changes add up to increased bearing loads which affect the fatigue life and embedability of bearing materials.

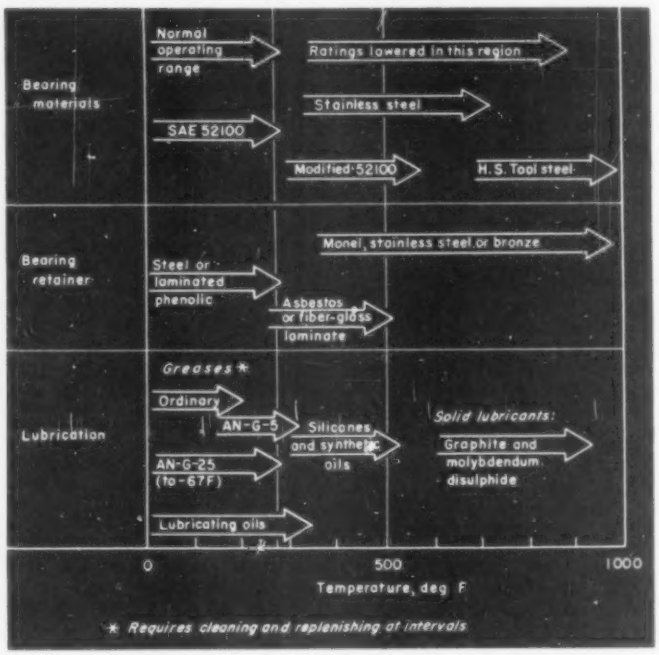
To improve the fatigue strength, stronger materials are required such as: copper-lead, aluminum alloys or silver. However, these materials are inferior in score resistance and embedability. In addition, there is the trend to reduce the thickness of the facing material on steel-backed bearings to as little as 0.001 in.

With increased loads, the oil film thickness becomes smaller and more critical to the presence of foreign material. This film at present is less than 0.0001 in. and with this extremely low value, there is the serious problem of filtering and cleaning oil. The practical limit of filtering fineness seems to be about 0.001 in. which means that the bearing material must be able to tolerate and embed such foreign materials which cannot be separated or removed.

For aircraft applications, journal bearings offer the advantage of greater durability and much lower costs; however, there are some problems which have not been solved. In high speed and lightly loaded applications, the problem of whirl or oil-whip is being worked on. This vibrational phenomena, which precesses at about half the shaft speed and in the same direction, is not fully understood to the extent to predict or prevent it. One method to avoid this problem has been by use of a segmental or pad (Michell type) bearing; however, these bearings must be geometrically symmetrical.

In applications where high temperatures are prevalent, one serious problem is that of lubrication. Synthetic fluids have been developed for operation up to 500 F. For higher temperatures up to 1,000 F work is being done on dry or solid lubricants embedded in the bearing materials. Use of a colloidal graphite in a light mineral oil which vaporizes and leaves a film of graphite is another means of obtaining lubrication. In these applications, the use of lead as a bearing alloy is to be avoided. Tungsten carbide and tool steels are also being investigated as possible bearing materials.

Fig. 7 — The severe operating conditions of high temperatures require not only special materials but improved lubricants. Using grease requires periodic cleaning and filling.

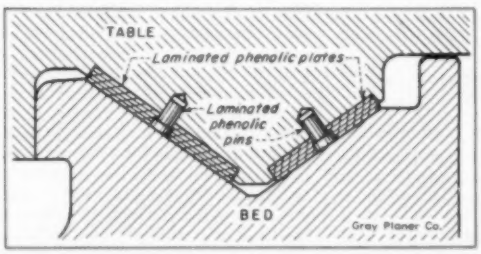


Bearing Design Vs Unusual Lubrication Systems

OIL-MIST or fog system of lubrication is by no means new; however, applications of such controlled lubrication have greatly increased. Basically, it consists of an air jet that breaks down the oil into microscopic particles which are delivered to bearing surfaces. Today there are several devices available which produce this type of lubrication.

This combination of air and oil has made possible the operation of high-speed spindle bearings. In such bearings, there is the problem of preventing excessive temperatures by providing a sufficient oil for full lubrication but not an oversupply which would increase the friction and raise the temperature by churning the excess oil.

Other features include a continuous slow flow of air out of the bearing, thereby preventing entrance of dust and also helping to cool the bearing. It uses a surprisingly small amount of oil and many different parts of a machine can be readily lubricated with a single mist unit.



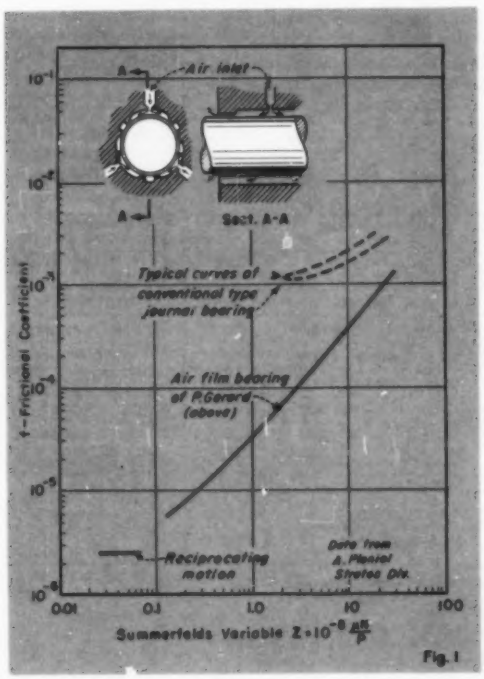


Fig. 1

Refinements in the oil-fog system have been in the creating of finer particles (about 2 microns in dia.) which are held longer in suspension and can be transmitted through lines of greater length. In addition, more thorough lubrication is possible particularly between closely fitted parts. Greater precision in rate of oil flow is possible: as low as one drop of oil in twenty minutes.

GRIDDED BEARING surfaces are being used in the machine tool field where the problem is to move very large and heavy masses smoothly. This grid, made up of a series of fine grooves cut into bearing surfaces at an angle, maintains an oil film which supports heavy loads with a lower static coefficient of friction and a much greater resistance to scoring. Higher loads are possible than if the entire bearing surface were polished smooth. This construction might be compared to that of gridded journal bearings, but in these, the grids are usually filled with a soft babbitt which serves to prevent scoring by embedding the foreign particles.

PLASTIC BEARING SURFACES have solved one of the problems in the metal-working industry which is the scoring and undue wear of the guides and ways of machine tools. This scoring not only interferes with the accuracy of the equipment, but also is costly due to constant maintenance work which is necessary. Using a phenolic laminated plastic to replace one metal bearing surface has shown excellent wear and scoring resistant qualities. This combination has proven satisfactory in applications with extremely low velocities up to 400 ft per min and at bearing loads of 50 psi. Lubricants used are similar to those for metal to metal contact.

EXTERNALLY PRESSURIZED or hydrodynamic bearings using either air or oil have been used for years but in limited applications. Newer applications are being developed and more data is being accumulated which should make this device more practical. Perhaps the earliest wide applications of forced pressure lubrication were in thrust bearings of large vertical turbine rotors where oil was pumped to lift the heavy shaft and float it on pressurized oil. This technique was soon extended to the journal bearings of horizontal turbines. Supported in this manner large rotors could be turned with a minimum of effort. This system is also used to support the rotating dome of the 200 in. telescope at Mt. Palomar. By properly proportioning the orifices and grooves, extremely heavy masses can be supported by means of the self adjusting oil pressures in the bearing chambers. Slight variations in oil supply pressure do not affect the performance of such a bearing.

Using air in place of oil as the fluid, the same principles are now being applied for the lubrication of high speed and instrument bearings. Using air has the advantage of an extremely low frictional resistance and there is no need to prevent spillage or spatter of the lubricant. Relative friction is illustrated in Fig. 1 where experimental data on a particular bearing is plotted. This type of bearing is being developed for applications in precision instruments, in the aircraft field and for high speed grinding spindles running 150,000 rpm and even higher.

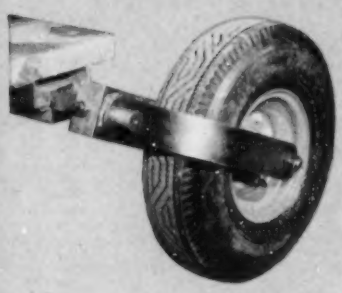
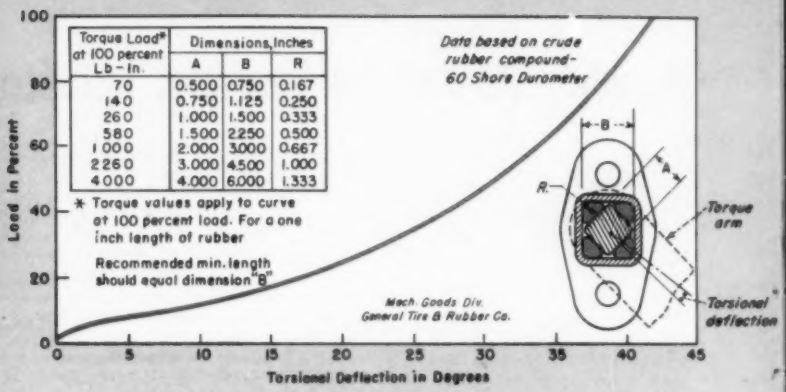


Fig. 1 — Independent wheel suspension is compact, light and utilizes four rubber elements in compression for resiliency.



Torque Load* at 100 percent Lb-in.	Dimensions, Inches A	B	R
70	0.500	0.750	0.167
140	0.750	1.125	0.250
260	1.000	1.500	0.333
580	1.500	2.250	0.500
1 000	2.000	3.000	0.667
2260	3.000	4.500	1.000
4000	4.000	6.000	1.333

* Torque values apply to curve at 100 percent load. For a one inch length of rubber

Recommended min. length should equal dimension "B"

Fig. 2 — Characteristic load-deflection chart of the Neidart spring. This curve and the table determine the proportions of the square-type illustrated.

Highlights on Selected Mechanical Parts

Because of the extent of recent developments and trends in the field of mechanical parts, any round-up or survey necessarily must be limited. An entire section could be written on developments in high speed cams; the fastening of metal parts alone is worthy of comprehensive coverage. But since space limitations and the broadness of the field restrict the scope of such treatment, the following four pages are devoted to highlights on but a few items.

Metal Stitching Speeds Joining

Stitching and stapling are speeding the assembly of both metal and non-metal sections to sheet metal components. Applications where the greatest economies are realized, are those in which metals are stitched to non-metallic materials. Maximum thicknesses that can be stitched are governed by machine capacity, as well as material combinations, hardnesses, grain structures, and shapes. Today there are a variety of machines serving a wide range of applications. In many cases, staples have replaced bolted, spot-welded or riveted connections.

Table I lists recommended thicknesses for the most frequently stitched materials. For metal to metal attachment, values at the left are used. As an example: hard aluminum (0.040 in.) can be stitched to annealed stainless steel 0.020 in. thick. Values at the right apply metal and non-metal joints: a 21 ga. galvanized sheet can be stitched to 3/16 in. asbestos.

Besides the materials used, stitch strengths are governed by the wire, its thickness, the type of clinch and the spacing. Four common types of clinches are used; however, the flat clinch has greatest strength. Stitches can be arranged in a vertical, horizontal or diagonal pattern. For example a 0.051 in. wire flat clinched through two 24 ST aluminum sheets (0.040 thick) have a shear strength of 557 lb for a horizontal or diagonal stitch and 476 lb for a vertical stitch (force parallel to wire). Metal stitching has been found to be quite resistant to vibration.

Table I — Recommended Maximum Material Thickness for Metal Stitching Using Flat Clinch

Metal to Metal				Metal to Non-Metals			
0.093	Thickness for any combination of these metals	0.093	Aluminum — Soft 3 S0, 52 S0, 61 S0, 24 S0 Alclad, 75 S0—SW	0.125	Thickness for any combination of these materials	1/8	Sheet Cork
0.064		0.064	Aluminum — Half Hard 3 S1/2H, 52 S1/2H	0.080		5/16	Leather
0.040		0.040	Aluminum — Hard 24 ST or Alclad, 61 ST, 75 ST	0.064		3/16	Sheet Asbestos
0.062		0.062	Aluminum Extrusion	0.093		1/4	Fiberboard
0.0348		0.0348	(20 ga) 1010 C.R. Steel[a]	0.0348		3/8	Sponge Rubber
0.0348		0.0348	(20 ga) Hot Rolled Steel[a]	0.0348		1/4	Solid Rubber
0.0310		0.031	(21 ga) Galvanized Sheet[a]	0.031		1/8	Phenolics[b]
0.010		0.010[c]	302 Stainless — Full Hard	0.010		3/16	Plastics[b]
0.012		0.012[c]	302 Stainless — 1/2 Hard	0.012		3/16	Std. Masonite
0.015		0.015	302 Stainless — 1/4 Hard	0.015		1/4	Temp. Masonite
0.020		0.020	302 Stainless — Annealed	0.020		3/16	Wood
0.030		0.030	Sheet Brass Soft	0.040		1/4	Plywood
0.035		0.035	Sheet Copper	0.045			

Notes: Thinner individual metal layers can be built-up but the total thickness should not exceed the values above.
(a) Hardness Rockwell B 50 or softer
(b) Must be soft enough to penetrate without cracking
(c) Not recommended for stitching Half hard and full hard together
Data compiled by Stitching Wire Div., Acme Steel Co., Chicago

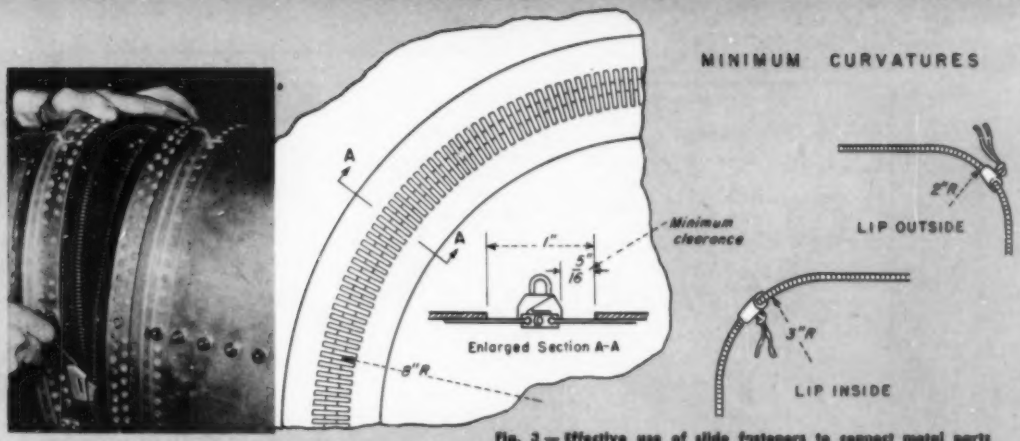


Fig. 3 — Effective use of slide fasteners to connect metal parts require design considerations. Here are minimum curvatures and clearances required for the pressure of seal type of zipper.
B. F. Goodrich Company

Torsional Rubber Springs

Designed and developed in Europe, this simple device (Neidart patent) Fig. 1, shows considerable promise. In many instances, it has replaced both the coiled and torsional types of springs. Since it consists of three separate elements, it can be readily assembled and has the advantage of a gradually increasing spring rate as shown in Fig. 2. This is particularly good for overload or shock conditions. Since the rubber is in compression, there is no fatigue limit. It has considerable design flexibility; by simply altering the proportions as shown in the table (Fig. 2), the load values can be increased or lowered. In addition, this characteristic curve can be changed by modifying the inner square form to concave surfaces and thus steepen the snubbing part of the curve. Instead of a square or four-sided members other geometrical shapes are possible, such as a 3, 5, 6, 7 or 8 sided polygons.

New Uses for Slide Fasteners

Zippers have been designed for either water-tight or air-tight seals. With overlapping rubber lips, they can effectively seal pressures from zero up to the structural strength of the fastener itself. These zippers can be applied to metal, fabric or rubber by either sewing or cementing, and be used at tempraturs up ot 180 F. For very low temperatures encountered in aircraft applications, a special rubber is required. The crosswise strength of the brass slide fasteners is 300 lb. per inch of length; for aluminum this value is 250 lb. per inch. The initial tension of the rubber sealing lips makes possible a seal for a slight vacuum of about 0.5 psi from the chain side. To most effectively use these slide fasteners, as shown in Fig. 3 there are certain minimum curvatures and clearances which should not be violated.

Metallic Bellows Assemblies

Welded bellows made with a specially shaped diaphragm have many unique features. By using heavier diaphragms near the end and lighter and more flexile ones at the center, the flexing action is more uniformly distributed throughout the bellows and each diaphragm works well within its elastic limit. Fig. 4 shows the diaphragm contour which permits not only large deflections but also a wide range in the number of diaphragms that can be used in a limited space. This type makes possible a controlled spring rate which, when used in a rotary seal, can exert a sufficient force to eliminate the need for a compression spring. In addition to permitting large offset conditions, it can be designed for driving shafts which are either offset or at an angle.

There has been a trend toward standardizing the design of formed bellows. This applies to the choice and gage of materials, and in the size, depth, pitch, and number of convolutions. Thus with a proper combination of factors, the designer can select satisfactory bellows. Much work has been done in design to avoid vibrational fatigue and for proper flexibility in applications subjected to corrosion, high temperature or large pressures.

One company is maintaining a

Fig. 4 — Greater latitude in design is possible with welded bellows. Larger area diaphragm, and thicker metal, are some of the possibilities.
Brewster Corp.

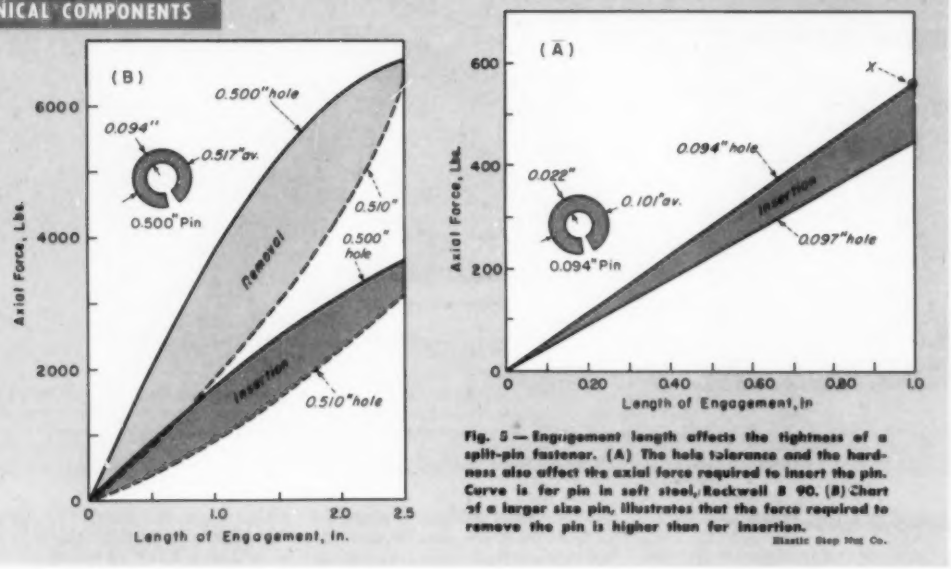


Fig. 5 — Engagement length affects the tightness of a split-pin fastener. (A) The hole tolerance and the hardness also affect the axial force required to insert the pin. Curve is for pin in soft steel, Rockwell B 90. (B) Chart of a larger size pin, illustrates that the force required to remove the pin is higher than for insertion.
Elastic Stop Nut Co.

stock of the most commonly used bellows. This should supply all urgent requests. The bellow sizes range from 5/16 to 4¼ in. OD; wall thickness of 0.003 to 0.010 in.; convolution pitch varies from 0.030 to 0.271 in.; the smallest are for pressures to 700 psi.

New Pin Fastener

An old principle, using a split cylindrical pin has been recently released in this country. When driven into a hole slightly smaller than the pin diameter, elastic pressure holds it securely in position. A shake-proof attachment can be made in drilled holes and close tolerances are unnecessary. The effect of recommended hole sizes on the restraining strength is shown in Fig. 5. Slightly greater effort is required to remove this pin as compared to that of insertion. The tightness of the pin is also a function of the material and its hardness into which the pin is inserted. If, in Fig. 5 (A), the material were hardened steel Rockwell C 60, point *X* would be about 740 lb; for brass or aluminum, it would be lower, approximately 500 lb. Under certain conditions, a satisfactory assembly can be made with as little as one diameter of the pin in engagement. One such example is the accelerator pedal bracket in Fig. 6 which is pressed into the center element and loose in the frame. To insure a vibration-proof assembly the recommended minimum length of engagement should be 2½ times the diameter.

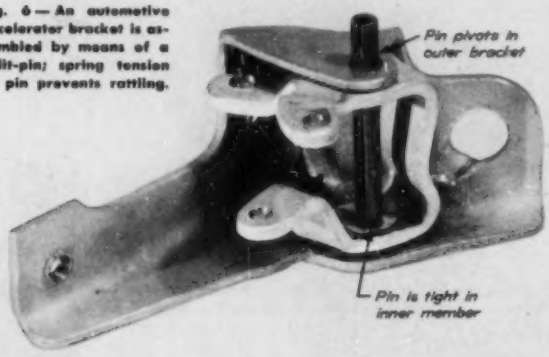


Fig. 6 — An automotive accelerator bracket is assembled by means of a split-pin; spring tension of pin prevents rattling.

Constant Force Spring

Made of flat spring stock which has been coiled by heavy prestressing, this elastic member in its relaxed or unstressed condition forms a tightly-wound spiral. To extend the outer end of this spring through very large deflections, the only force required is that which is necessary to straighten the material located in the Y zone (see Fig. 7). This energy is stored in the L zone and is released as this strip again passes through the Y zone. For applications which require torque effort there are two common devices which utilize the properties of this elastic member called the Negator. In Fig. 8, case *A* illustrates an expanded coil which tends to unwind from the larger spindle R_2 and wrap around the smaller spindle R_1. In case *B* the spring is reverse-bent around the larger spindle and produces more torque because of the greater internal stress caused by the reverse-bent condition. Using this device a planetary gear drive mechanism was used to retract 50 feet of tape where only 8 feet was the maximum length using a conventional spring.

Automatic Feeding and Sorting Mechanisms

Automatic machinery requires automatic methods of feeding, counting, and sorting. (see PRODUCT ENGINEERING, October 1950) That there will be increasing emphasis on such devices in the future there is not much doubt, especially as high-speed in-

spection devices are coupled, directly or indirectly to the exit-end of machines.

Feeders operating on the vibration principle are increasing in use. By means of electromagnetic vibration, small parts can be oriented and fed to automatic processing machines. All kinds of materials with a variety of shapes can be handled without damage in this mechanism. One such device consists of a hopper with a convex bottom; torsional pulsations gently move the parts to the edges and up a spiral trough. With this, complex shaped parts such as zipper clips can be arranged and fed automatically. In addition, washers, bolts, balls, and other parts can be handled; and arranged in a specific position such as heads or tails first, face up or face down, on one side or the other depending on requirements. Using a taller spiral trough, similar feeders are available for raising materials vertically.

Unusually Large Bearings

Anti-friction bearings recently have been made as large as 120 in. in diameter and held within 0.002 in. tolerance. To obtain the full load-carrying capacity, these bearing raceways are hardened by means of a special deep flame-hardening process which avoids the possibility of distortion and warpage which would normally occur during conventional hardening. Using rollers which are alternately positioned to roll at 90 deg to one another, either thrust or radial loads or a combination of both are possible. Such bearings are designed for low speed applications.

Retaining Rings Simplify Assembly

Today there are a large number of different types of rings from which the designer can choose. They may be wire, stamped, or shaped; annealed or hardened; grooved type or self retaining; beveled or bowed.

To eliminate axial looseness, bowed rings are available in both the standard and E types to take up clearances of 0.020 and 0.035 in. respectively for the 1 in. size. Rings with a 15 deg taper exert greater axial force for same size; however, the maximum take up is much less: 0.005 in.

In using these rings for external applications, the problem of centrifugal force should be considered. Fig. 9 graphically illustrates the maximum permissible operating speed these rings can tolerate without loosening in their grooves. Curve shows the benefit of smaller sizes.

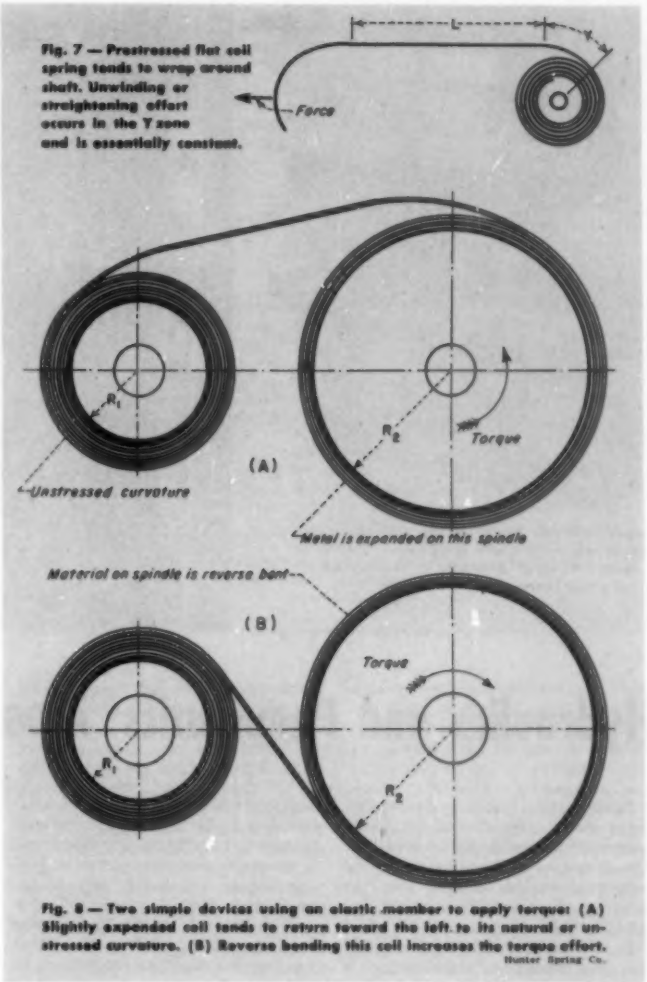


Fig. 8 — Two simple devices using an elastic member to apply torque: (A) Slightly expanded coil tends to return toward the left to its natural or unstressed curvature. (B) Reverse bending this coil increases the torque effort. Hunter Spring Co.

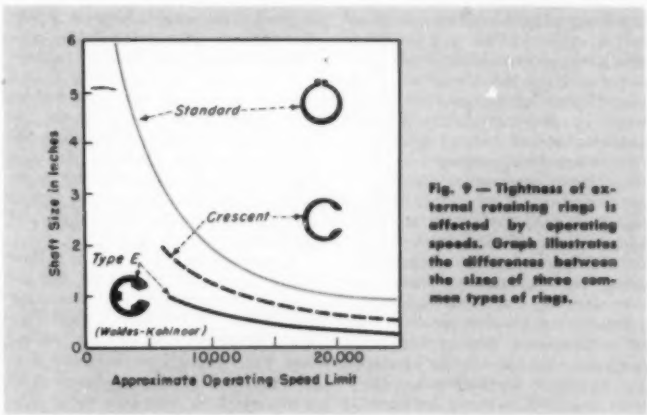
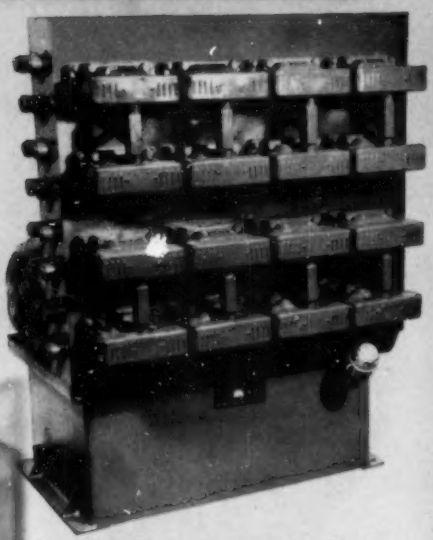
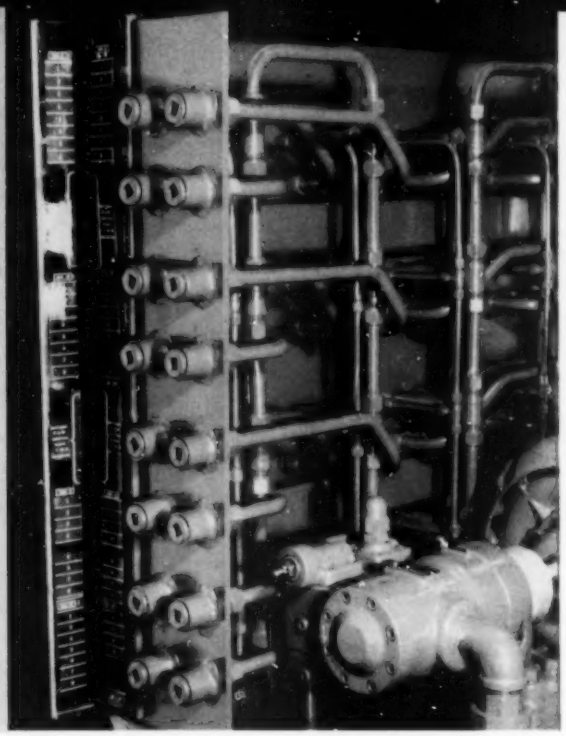


Fig. 9 — Tightness of external retaining rings is effected by operating speeds. Graph illustrates the differences between the sizes of three common types of rings.



Packaged hydraulic power system with reservoir, valves, piping, motors and pumps assembled as a unit. Note the panel mounting of valves and of inlet and outlet connections.

Vickers Incorporated



Hydraulics and Pneumatics: *PROGRESS EVALUATION*

In evaluating trends in hydraulics, three basic categories of hydraulic equipment should be considered. The first two of these relate to the industrial hydraulic field and the third is, of course, the aircraft hydraulics field.

In the industrial hydraulics field the first significant classification is machine tool hydraulics which actually designate the kind of equipment that is applied to all types of processing machinery either directly relating to an actual machine tool or other forms of comparable equipment. In this particular field the emphasis is on maintenance considerations. First proposed by General Motors and other automotive companies, a set of design criteria called the Joint Industries Committee Hydraulic Standards for Industrial Equipment have been established which broadly define the necessity for, first, accessibility of hydraulic components on machinery for adjustment and maintenance purposes, and second, the appropriate design of the hydraulic equipment to permit its ready disassembly and overhaul in the event of malfunction. In the past it has been customary to bury hydraulic equipment in inconspicuous places in or on machine tools and design the equipment such that it was rigidly installed in the connecting piping between pumps, valves and other mechanisms. Now the emphasis is on the use of panel mounted valves (see illustrations) so arranged that it is not necessary to break any connecting lines to remove and replace a defective valve. The design of hydraulic reservoirs has also undergone complete revamping in the direction of providing adequate provisions for rapid draining, cleaning and refilling. Compliance with these requirements is forcing extensive redesigns on all the major hydraulic manufacturers.

A standardization program is now being developed to reduce the almost infinite number of valves now available. This will reduce the manufacturing costs of the valves and will also relieve the confusion in the mind of the engineer who must choose the valve he wants. Another goal the industry is working for is to achieve comparable characteristics between valves with different types of controls. For example, a manual operating valve might have certain capacity flow characteristics, while a solenoid operating valve of the same size might have entirely different ratings. It is hoped that in the future all valves of the same size will have the same performance characteristics, whether operated mechanically, manually, electrically, pneumatically or hydraulically.

There is of course a growing tendancy toward the greater use of hydraulic power combined with electrical signal and control systems. This combination is ideally suited for delivering and controlling power to a remote location. This noticeable trend of the past few years has reverted the earlier trend toward "all-hydraulic" systems.

Other than for this emphasis on improved maintenance, machine tool hydraulic design is continuing largely as in the past. There is some tendency toward the use of slightly

LUBRICATING OILS AND GREASES

No new post war lubricating oils or greases have come into prominence. Better refining processes and new additives have edged quality up all along the line. This trend will continue as additives are perfected and new designs require better characteristics.

The big majority of mineral base lubricants are additive types. Premium grade automotive and diesel lubricants now run 3 to 6 percent additive, and the future should push this all the way up to 20 percent. The 1951 automobile manuals cover usage of "super" oils, one grade above the present commercial "premiums."

Additives are settling into four types:

1—Detergents and Oxidation Inhibitors. These are required for long-life lubricants, small bearing clearances, and high temperature applications.

2—Corrosion Inhibitors. Silver and special metal bearings are corroded by the sulphur content of normal oils and combustion gas contamination.

3—Lubricity Improvers. The coefficient of friction is lowered.

4—Viscosity Index Improvers. Lubricant does not thin or thicken with temperature changes as much as a pure petroleum product. Oils so treated tend to break down somewhat easily at high pressures, but a variety of synthetic stabilizers are available to correct this fault.

ALL-PURPOSE LUBRICANTS

Most oil companies and consumers feel that all-purpose lubricants are being used about as much now as their price warrants. The trend in the future may be to these "do everything" oils and greases, but rather slowly.

Military equipment is one application of all-purpose greases. Lithium greases (all-temperature greases) are a definite saving in the added simplicity of servicing just about everything on an airplane from the same can. An airplane that goes from tropic sea level to —65 F altitude needs an all-temperature grease.

A tank that may go to Alaska or Africa after being lubricated at assembly line also needs universal, lithium grease. Re-lubricating a tank takes 300 man hours.

SYNTHETIC LUBRICANTS

Military need for greater operating temperature range than is possible with any petroleum base lubricants has pushed development of entirely synthetic compounds. The first applications will probably be in truck and tank crankcase oils for Artic operation. Aircraft crankcase oils are also a possibility.

The cost of synthetics is high and will most probably always be somewhat above that of mineral base lubricants which start from a natural raw material base. The gap will be closed as synthetic oils and greases are produced in greater quantities and performance requirements push additive content of petroleum products up, however.

UNUSUAL LUBRICATION

Research is being done on the flow properties of greases for central lubricating systems. Good progress is being made.

Oil-mist lubrication is good, if confined to high speed bearings. Practically speaking, use of an oil-mist results in lubrication about half way between liquid oil and the Kingsbury air bearing used in guided missiles.

The use of graphite greases is increasing as high load bearing materials are developed. Solid lubricants (molybdenum disulphide) are one step further along the line and are now under serious development.

higher hydraulic pressures but this is not a significant trend at this time. A maximum pressure of 1,500 psi and an operating speed of 3,600 seem to be well established, although higher working pressures are used on some special single-purpose machine tools.

Higher pressures of course conserve plant space, permit easier shipment of equipment and allow greater flexibility in position of components because of reduced size. Although higher pressure circuits create many problems (a slight leak at 5,000 psi may mean serious problems) increased usage may bring overall cost (initial + upkeep) of 5,000 psi systems below that for lower pressure systems within the next decade.

Smaller pumps, actuators, valves and lines can be used with higher pressure. Small pipe (1 in. and below) is safer than larger lines due to commercial practice on wall thicknesses. Small tubing is also easier to attach to fittings.

Currently "O" ring seals are standard at 1,000-3,000 psi while "V" rings are used on 5,000 psi industrial systems. Research on even higher pressures up to 20,000 psi indicates that brazed manifolds and "O" ring-flange unions will be adequate for fittings. Welded joints are good on performance, but usually expensive and difficult to fabricate, on the job.

Another important trend is the growing realization that most hydraulic circuits are intermittent in operation and that a study of the duty cycle preliminary to design results in important savings in the size and capacity of pumps and fittings. Accumulators are one solution used. Pressure compensated, variable-volume, self-unloading pumps are the other important means used to allow the pump to operate only when necessary in the cycle.

There is also an increasing call for package power units with the advantage that the control panel is mounted directly on the fluid reservoir along with the pump and drive motor. Sometimes the entire package is inclosed in a metal cabinet and the unit installed wherever most desirable for accessibility and neat appearance. With this design the whole hydraulic unit can be picked up and moved without disturbing the machine tool.

Hydraulics for Mobile Equipment

The second category of industrial hydraulics is generally defined as the mobile equipment field—tractors, material handling equipment, road graders and farm machinery. There has been a steady increase in the pressure requirements of the mobile equipment field because of the obvious desirability of obtaining more power in a smaller package on units which are in themselves critical in overall weight and size. Here again, however, the trend to higher pressures is moving slowly and largely is being paced by the obtainability of improved hoses and fittings. On rotating equipment, such as hydraulic pumps and motors, higher operating speeds are being used in the interest of decreasing size, weight and cost, and this trend will undoubtedly continue.

Construction machinery uses hydraulics for operations such as adjusting scraper blades, which hydraulic cylinders can do with great accuracy. Power steering, while not new, is increasing in popularity for heavy road machinery, construction equipment and automobiles, trucks and buses as well. Pumps and hydraulic units in these applications are rapidly growing larger, having increased from a few gallons per minute capacity to a delivery rating of hundreds of gallons per minute. The optimum pressures at this time seem to have settled in the neighborhood of 1,500 psi and fluid motor operating speeds of 3,600 rpm are in

the blueprint stage. It is doubtful whether these figures will be increased.

In mobile equipment a direct drive from engine to pump is favored, thereby making pulleys and gear boxes unnecessary.

Aircraft Hydraulics

In the field of aircraft hydraulics there are several significant new trends in design taking place. Of these perhaps the most important is the present development of non-inflammable fluids which will provide both adequate hydraulic fluid characteristics and a sufficient degree of non-inflammability to obviate the danger of fire in the airplane in the event of system leaks or malfunctions. Definite progress is being made in this direction and some types of both military and civilian airplanes are today successfully flying with non-inflammable fluids installed (see Hydraulic Fluids).

The next significant trend in the aircraft hydraulic field is the use of higher operating oil temperatures. High speed aircraft appreciably raise the temperature of the air coming in contact with the airplane so that oil cooling to normal operating temperature is almost impossible to achieve. As a result there is a definite trend toward the use of extremely high oil temperatures in the range of 300 F or higher. Needless to say these high oil temperatures represent a severe problem to the hydraulic manufacturer and a great deal of development is under way to aid in the solution of these problems.

The third trend in aircraft hydraulics is the general increase in the permissible operating speeds on rotating components of hydraulic equipment. The Hydraulic Division of Sundstrand Machine Tool Co., for example, has a high horsepower hydraulic transmission running at speeds as high as 9,000 rpm as does Vickers, Inc., and other hydraulic manufacturers are also designing and supplying equipment to the industry for comparable speeds. This contrasts with the 1,200 to 3,000 rpm maximum speeds that existed a few years ago.

Some engineers in the industry consider higher pressures a possibility in aircraft hydraulics. There has been consideration given to 5,000 psi

Earthmoving machines rely on hydraulic power for actuation

The road scraper made by Euclid Road Machinery Company uses hydraulic power for controlling the scraper blade and apron. This particular unit has an engine in the tractor and a separate engine that is coupled to the rear wheels through a torque converter. Hydraulic boosters are used for steering.

This MRS tractor utilizes a hydraulic cylinder to transfer the weight of the load from the front wheels of the scraper to the rear wheels of the tractor when additional traction is required. Thus, weight distribution is under control of the operator.

Left — Hough Model HM Payloader depends upon a hydraulic system for raising, tilting and dumping the bucket. On this particular model, hydraulic steering is also used, although mechanical steering is more common on smaller units.

Right — Combined mechanical and hydraulic power is used to raise and lower the digging head on this Barber-Greene trencher. The hydraulic cylinder, which lies along the channel at the top of the machine, is reeved two to one to a cable hoist that raises and lowers the head.

Photos courtesy Hydraulic Equipment Company

systems for aircraft and it may be that these higher pressures are in the future for tomorrow's airplanes. However, there does not seem to be any serious move at the present time above the present generally accepted 3,000 psi operating pressure, and there probably will not be any serious activity in this direction for two or three more years.

Because higher pressure means greater wall thickness and greater weight it is not expected that there will be any appreciable further increase beyond 5,000 psi for aircraft. Also, higher pressures require closer tolerances and hence higher costs. This last limitation is not a factor in military aircraft. Finally, there is the limitation caused by the compressibility of the fluids. This usually can be ignored at lower pressures but above 3,000 psi the effects are more than noticeable.

Other problems with reference to the design of hydraulic units are related to problems created by the increased bearing loads and the need for more effective sealing devices.

Pneumatic Systems

Pneumatic systems for actuation of auxiliary devices on production machinery—especially fixtures—have increased rapidly these past few years. High vacuum equipment, both for processing and basic research is progressing at a pace that has resulted in new departments being established in several of the larger manufacturing companies to handle design of equipment. Centralized air systems also have been installed for machine actuation when the fire hazard has made use of hydraulic fluids undesirable. In addition to these applications, air devices probably will be used in increasing numbers in mobile and transportation equipment, both because of increased safety and decreased weight.

Pneumatic systems for aircraft are currently receiving considerable attention. Pneumatic actuation was used by the British (on the Spitfire) before being taken up in the last few years by American designers. Temperature extremes are not as critical as with hydraulic systems. Pneumatic systems are cleaner and somewhat easier to service than hydraulic. Absence of return lines cuts weight. There is no fire hazard. Trial applications in America are on big planes, but as the system proves itself, small plane installations will be made.

Unanimous opinion is that pneumatics are well suited to brake systems. Better control is achieved and the fire hazard with hot brakes is not present. Pneumatic brakes will be applied first to large planes where air and hydraulic systems can be used jointly.

There is no such general agreement as to pneumatic flight control boosters. Experimental systems are spongy and still have design bugs. Much development is still needed.

Compressors are the heart of pneumatic systems. Compressors for 1,500 psi are now available and several 3,000 psi designs will be unveiled in the near future. These will overcome former objections of being weak and bulky. Multi-stage (usually 3 stage) piston designs, taking air from jet engine compressors, are standard.

Air bottles, close to operating units, are being used for emergency operation in the event of main hydraulic, pneumatic or electric actuating system failure. Standard bottle pressures, furnished commercially, of 3,000 psi present a problem with recent 3,000 psi main hydraulic and pneumatic systems. The pressure drops as the bottle evacuates and there may not be enough force to operate the unit all the way. Lower temperatures encountered at high altitudes also causes pressure decrease. On recently developed designs this pressure drop is being made up by auxiliary engine-mounted compressors operating only for emergency systems.

HYDRAULIC FLUIDS

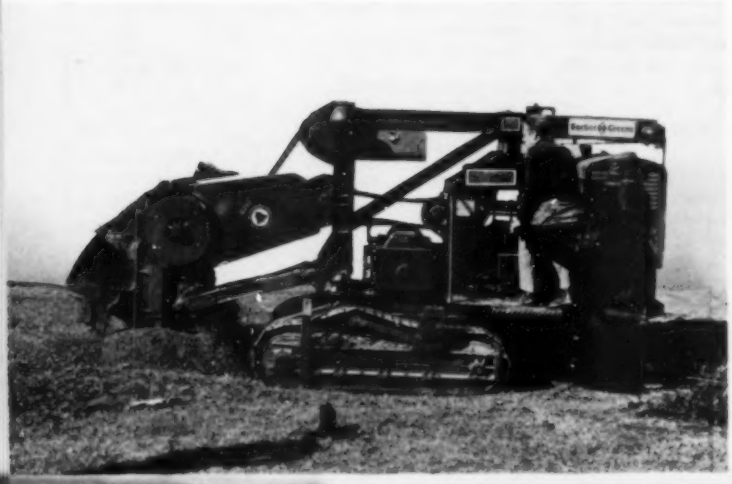
On many industrial and most aircraft applications, non-inflammable hydraulic fluids are desirable. Completely synthetic fluids and soluble oils that mix with water are the two approaches being tried.

Soluble oils will be used, mixed in proportions down to 1 part of oil to 100 parts of water, with preservative additives to stabilize oil and prevent rust. They are limited to the boiling point of water. They can be taken down to −65 F, although fluids for low temperatures are expensive. One advantage is that soluble oil fluids do not appreciably affect present synthetic rubber seals.

Soluble oil fluids will probably cover most fire-prevention applications in industrial equipment and commercial aircraft in the next few years. Even at rather high temperatures, where water evaporates, it is a cheap process to add make-up water.

Silicone oils and chlorinated fluids are popular candidates in the search for synthetic hydraulic fluids to cover the wide temperature range (−100 to +400 F) desired for military aircraft. A big problem is that they are natural solvents for synthetic rubber and new seal compounds must be found. None has been really perfected for the really wide temperature range fluids to date. Perhaps military security has put some good developments in the shadows here, however.

In any case, there is a desire on the part of most engineers to have non-inflammable fluid on just about every hydraulic application, and the future will see them developed.



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We Must Pay As We Go

***We** must do our utmost to pay as we go for our present defense program.*

On that proposition those who speak with authority are remarkably well agreed. This editorial – the second in a series on our mobilization for freedom – sets forth in simple terms why there is this agreement.

Next year – the fiscal year beginning next July 1 – the federal government's budget calls for the expenditure of $10 billion more than is scheduled to be collected in taxes. The deficit is due to the increase in defense expenditures.

A part of this deficit can be eliminated by cutting non-essential expenditures and increasing efficiency in the defense program. There is wide agreement on this. It is the duty of the President and Congress to see that it is saved.

How the remaining deficit anticipated in the federal budget—$5 billion to $10 billion—is handled is crucial. The government can meet it by raising taxes—by paying as we go. Or it can borrow, issuing more government bonds.

Borrow Again?

We relied heavily on borrowing in both World War I and World War II. In World War I only about one-third of the expenditures of the federal government were met by taxation. In World War II about 45 percent were met in this way. The rest we borrowed. Some people ask, why can't we rely heavily on borrowing again? Why is it crucially important to avoid adding $5 billion to $10 billion to a federal debt that is already $257 billion?

Part of the answer is found in the contrast between this defense program and our all-out effort of World War II. Another part—and one that is all-important in combatting inflation—results from the rapid decline in the purchasing power of the American dollar in recent years.

We went "all out" in World War II. We put almost half of everything we produced into our military effort. Taxes high enough to pay the financial costs as incurred would have meant huge tax increases. It was feared that such increases would kill financial incentives to get "all out" production. Since we expected the war to be short, borrowing seemed a safe expedient. Price control and rationing, with wartime patriotism to give them effective support, were relied upon to keep in check the inflationary pressure created by borrowing rather than taxing.

Our present defense program is scheduled to take a much smaller share of our production, but to take it over a much longer period. At its peak, the program as now planned will take only about 20 percent of our total national production. But, to use General Bradley's phrase, "the conditions under which we labor may persist for ten, fifteen and twenty years."

What About Controls?

For a period of any such duration it would be foolhardy to expect that the sort of controls we had for the few years of World War II could hold in check the inflationary pressure created by not paying as we go. It would be as foolhardy as it would be for a family to plan on borrowing to pay the expenses of a member discovered to be afflicted by a chronic ailment which might last a long lifetime.

Obviously, the only safe thing to do in such a case would be to adjust the family budget so that the expenses of the illness would be paid currently.

Our heavy reliance on borrowing in World War II had consequences which block a successful repeat performance.

If the borrowing had been done by persuading individuals to transfer their savings into government bonds, relatively little inflationary pressure would have been created. What the government would have spent with the proceeds of such bond sales would have been subtracted from the money individual consumers could spend.

But most of the borrowing was done from banks. That course expanded the amount of money available to the government without any offsetting subtraction of money from the hands of individuals. Thus, when direct price controls were removed after the war, this bottled-up purchasing power contributed to a price inflation which has cut purchasing power of the American dollar about in half – and decidedly changed the attitudes of the American people toward that dollar.

During World War II, Americans in general believed that:

The war would not last long.

The dollar would hold its value, and even gain value after the war.

Many wonderful new products would be available in the postwar period.

Today the American people have:

Seen the value of their dollars melt away fast.

Been assured that, at best, we may have a 10-15-20-year pull ahead.

Been warned not to expect a postwar paradise anytime soon.

One result of these changed attitudes is a notable lack of enthusiasm for government bonds on the part of individual investors. This is indicated by the fact that since Korea redemptions of E bonds have exceeded sales by about $600 million. Another result is a continuing rush to convert dollars into physical goods and equipment or claims on them. This trend weighs against financing the prospective federal deficit by borrowing from individuals.

Borrowing from banks to meet the deficit would again add fuel to inflation.

The prospective deficit is due to federal expenditures for military goods. Even if they are not blown up or shipped abroad, these goods will not be available to civilians. But the money paid to those who produce military goods will still be available to bid up the prices of civilian goods. Thus, at a time when people show relatively little disposition to save dollars, a menacing inflationary pressure – an inflationary gap, the economists call it – will be created.

If our fight against inflation is to be successful this gap must be closed by taxes. We need to do other things, too, for inflation has many different causes. Credit expansion must be effectively controlled. Production of civilian goods must be increased as much as possible by eliminating waste and inefficiency. But a pay-as-we-go tax program is basic to a successful attack on inflation. And inflation – unless it is checked – could wreck our defense effort.

We cannot pay as we go merely by soaking harder the corporations and those in the upper income brackets.

As the President's Council of Economic Advisers has reported, "by far the largest part of the additional revenue must come from the middle and lower tax brackets. These are the brackets in which the great bulk of the income is located."

Taxes Can Attack Inflation

By spreading tax increases broadly, taking small amounts from many people, inflationary pressure would be effectively reduced. It is the expenditures of the great mass of people, rather than the small numbers in the upper income tax brackets, that create most of the pressure. Moreover, it is possible to increase taxes broadly without killing the economic incentives to produce. Maintaining these incentives is essential to the success of the defense effort.

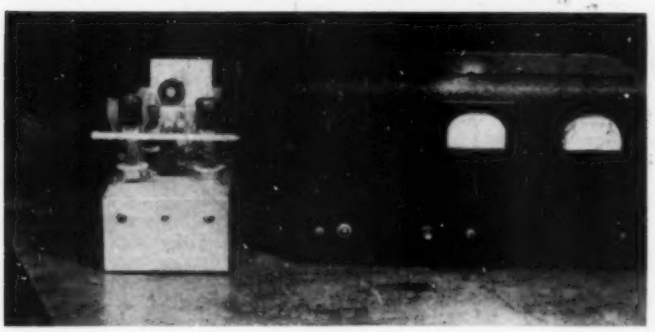
Our elected representatives cannot be expected to be enthusiastic about a pay-as-we-go tax program. It involves increasing the taxes of the great body of their constituents, an operation completely lacking in political glamour. However, such a program also involves the integrity of the American dollar. And that is absolutely essential to the success of the defense program. We shall be very foolish if we do not let our leaders know that we want them to do everything possible to pay as we go.

McGraw-Hill Publishing Company, Inc.

TECHNICAL NEWS

Atomic Standards of Length Now Available to Industry

DR. WM. F. MEGGERS POSITIONS THE EYEPIECE of the optical train prior to observation of the circular interference fringes of green light from the electrodeless Hg 198 lamp (left foreground). Length measurements based on this interference pattern (background) can be made within one part of 100 million.



THE NBS—MEGGERS MERCURY 198 LAMPS, excited by the application of high frequency radio waves, appears to have infinite life. This lamp, shown here in a life test at the NBS, has been under continuous excitation for over 10,000 hours with no significant deterioration.

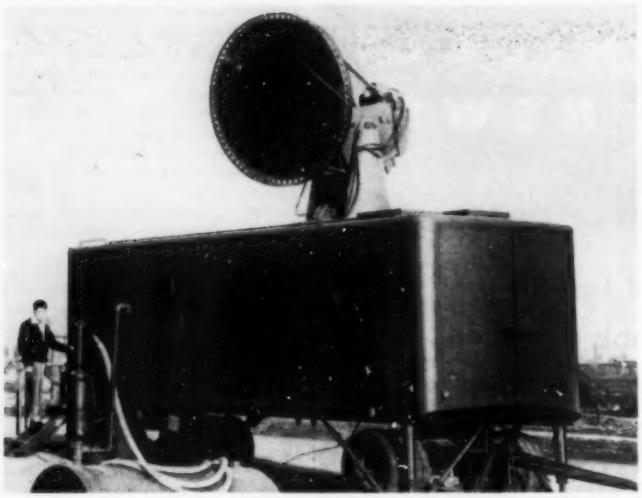
WASHINGTON — Spectroscopic lamps containing a single pure isotope of mercury enable any research organization that has the necessary auxiliary optical equipment to have for the first time an ultimate primary standard of length in its own laboratories. These lamps are available to science and industry from the National Bureau of Standards. All requests and applications should be addressed to the Coordinator of Atomic Energy Commission Projects at the National Bureau of Standards, Washington 25, D. C.

This NBS-Meggers Mercury 198 lamp contains about one milligram of mercury of atomic weight 198, which is obtained by the transmutation of gold in a nuclear chain-reacting pile. The mercury is sealed in a small glass tube and caused to glow brightly by the application of high frequency radio waves. These light waves have sharply defined wave lengths that can be used for length measurements of great precision. These particular waves are characteristic of mercury and remain unaltered with time.

The new standard of length is based upon the wavelength of the green light emitted by the lamp and is about 21 millionths of an inch. Reproducibility is greater than one part in a billion. Length measurements can be made readily within one part in 100 million. The technique used in such measurements consists of determining the number of wavelengths of light between two precisely flat plates.

Although the world's official primary standard of length is still the distance between two lines on a metal bar, practically all precise measurements of length in the 20th century have been made with light waves. The wavelength of the red light from cadmium has been used as a standard wavelength up to now, but since the wavelengths of mercury are more sharply defined, the wavelength of Mercury 198 may be made the new standard.

Other advantages of mercury are that the atoms are heavier and hence disturb the wavelength less; and the light can be obtained without heating the mercury to a high temperature. When all advantages are considered, Hg. 198 provides a standard at 300 percent greater accuracy.



Improved Firecontrol Unit Developed by Bell Labs

NEW YORK—An anti-aircraft fire control system that is far more effective and more flexible than World War II models has been developed by The Bell Telephone Laboratories for the Army and is now in production at the Western Electric Company.

With the earlier model, a hostile plane was found and tracked by radar. Continuous information concerning the plane's location was fed into a computer which was the heart of the system. At the same time, wind velocity, muzzle velocity, temperature and similar factors were also given to the computer. This machine then automatically calculated where a shell should explode to destroy the plane and aimed the guns to do just that.

The new system, adaptable to firing either 90 mm or 120 mm anti-aircraft batteries, operates on the same general principle but assembles and processes more information faster and more accurately. New circuits and circuit elements have been introduced to account for recent advances in plane and projectile performance.

A light-weight trailer assembles the maze of complex electronic equipment into a compact and portable unit that can be towed cross-country along with the gun battery or can be transported by plane. It also is floatable, so that it can even be towed across rivers and lakes.

Vacuum Bottle Holds Liquid Helium 100 Days

A VACUUM BOTTLE that can hold the world's coldest liquid 15 times longer than the best container previously available has been developed at the Westinghouse Research Laboratories. Constructed of copper, the new vacuum bottle will hold four gallons of liquid helium, used by scientists in studies of materials at sub-zero temperatures, at a temperature of only eight degrees above absolute zero for 100 days.

Dr. Aaron Wexler announced the new device at a Symposium on Low Temperature Physics held at the U. S. Bureau of Standards, Washington, D. C. He collaborated in its design and construction with Howard S. Jacket of the Hofman Laboratories, Inc., Newark, N. J.

The new vacuum bottle consists of two highly polished copper spheres, one inside the other, about a foot in diameter. Most of the air is evacuated from the area between the two spheres. The bottle is immersed in a tank of liquid nitrogen at a temperature of —300 F to minimize heat losses.

Heart of the new device is contained in the long narrow neck tube through which the liquid helium is poured. Since practically all of the heat transmitted into the interior of the bottle is conducted down the surface of the neck tube, the tube was made only slightly more than a half-inch in diameter, its length was increased, and thin-walled metal was used. Through such design, the heat inflow was reduced by 90 percent.

What happens is that the supercold helium vapors coming from the container serve to refrigerate the neck tube. This essentially neutralizes the transmitted outside heat and thereby narrows the temperature gap between the tube and the helium. By improvements in the design of the tube, the Westinghouse scientist predicted, more efficient containers can be made.

Powerful Jet Engine Revealed

THE MOST POWERFUL TURBOJET ENGINE in the world has successfully completed ground tests that qualify it for quantity production according to Navy and Westinghouse Electric Corporation spokesmen. The new jet, the J40, uses less fuel per pound of thrust than its predecessor, the J34. Designed by Westinghouse engineers under the guidance of the Navy Bureau of Aeronautics. It packs more potential speed into less space than any previous rotating engine ever built, according to Westinghouse officials.

The thrust developed, equivalent to 14,000 horsepower at modern flight speeds, is for a bare engine, without thrust augmentation. The addition of an afterburner to reheat the exhaust gases, after they leave the turbine and before they emerge as a jet stream from the rear, together with other developments now in progress, is expected to almost double this figure.

The J40 is one of the most efficient basic operational turbojets, as well as the most powerful, yet to be made available to the armed forces. A group of high-performance military aircraft, now in the prototype production stage, has been designed especially to take advantage of the performance capabilities of the new engine.

Operation is claimed to be simpler for the pilot than driving his car. The engine's electronic control system is completely integrated and automatic, from standstill to top altitude and speed. From starting to full power, and under any conditions of flight or altitude, operation of the engine is accomplished with a single cockpit control, equivalent to a throttle. All engine conditions are, in turn, automatically tied to this control.

The J40 is of the axial-flow design. But unlike its predecessors, which take

in air through a circular orifice, the air intake of the J40 is divided into two elliptical openings, arranged like the letter Y. To maintain a minimum diameter for the engine as a whole, major engine and aircraft accessories are mounted between the arms of the Y, while minor accessories are strung out along the sides of the barrel of the engine to conserve space.

Like all Westinghouse jets, the J40 uses an annular combustion chamber for a smaller combustor diameter than is possible with a number of separate can-type combustors arranged in a circle around the shaft. It involves a single flame, which is easier to control under difficult conditions than the multiple fires used in can-type combustors.

Due to the heat expansion of its various parts when it is converting air into power, the J40 grows a full inch in length. This requires engine mounts in which this growth is taken into account.

It has been under development only since June, 1947, when the Navy contract was signed.

Electronic Machine Counts Paper Money

THE DEVELOPMENT OF an automatic, electronic machine by the National Bureau of Standards for counting old paper money has been announced. Sponsored by the Department of the Treasury, which will soon begin to use the NBS Electronic Currency Counters, the machines were designed and developed by H. M. Joseph and Carroll Stansbury of the National Bureau of Standards.

The NBS Electronic Currency counter counts 30,000 bills per hour.

Money returned to the Treasury is in the form of stacks of 100 notes, cut in half lengthwise. The NBS Electronic Currency Counter counts the half-notes in these packets and automatically rejects those with more or less than 100. Packets of stapled half-notes are placed on an inclined trough. When the counter is turned on, a metal finger pulls the bottom packet into the machine. The stapled end is grasped by metal jaws and the packet is wrapped tightly around a spindle, spreading the outer edges of the notes against a curved metal plate. The spindle then rotates the ends of the notes while a jet of air separates the notes from the packet.

The counting is achieved by using an electronic sensing device consisting of a beam of light and a photoelectric system. As the notes are unfurled interrupting the beam of light, the photoelectric tube counts them by sensing the interruptions of the beam. Impulses from the electric eye go into an electronic arithmetic unit, which tallies the individual impulses. The sum of these impulses is used to actuate a sorting vane. If the count is 100, the sorting mechanism automatically sends the packet into an acceptance bin; if the count is more or less than 100, the packet is automatically ejected into a reject bin so that the rejects can be checked. Except for filling the trough with packets to be counted and removing those already counted, the machine operates unattended. In case of failures, it shuts itself off.

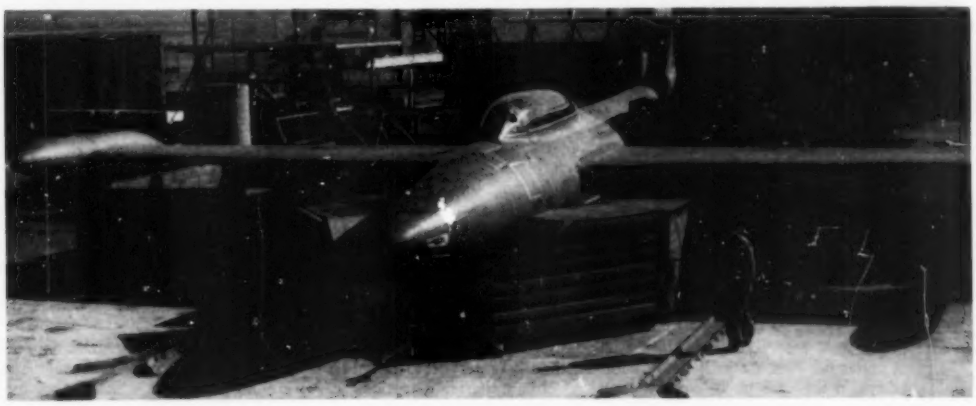
Test Racks Developed to Quiet Jet Plane Noise

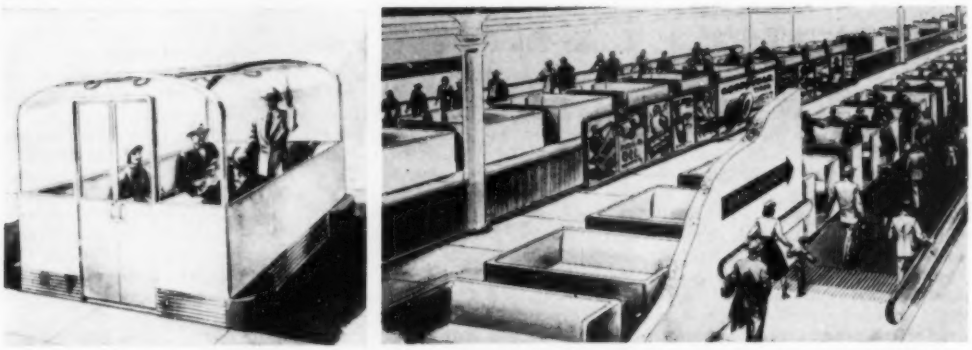
SAN FRANCISCO — Two aircraft companies have recently come up with new devices to cut down noise from jet engine testing.

Northrop has announced development of a 95 ft long muffler for its Scorpion F-89. The muffler is constructed of sound-absorbent volcanic ash building blocks supported by a steel framework. Secret to its success, say company engineers, is use of aerodynamically-designed free air inlet ducts, which supply tremendous quantities of air for cooling, velocity reduction and sound suppression. More than four times the amount of air by weight is pulled through the muffler than is emitted by the jet engines.

Lockheed Aircraft Corp.'s device augments jet exhaust-muffling Maxim silencers already in use. The acoustic shield controls noise sources other than exhaust by curbing the engine compressor's high-pitched whine, the whistle of air streaming into power-plant intake ducts and the thunder from vibrations of the fuselage, which sounds like a booming drum.

The Lockheed acoustic shield is constructed in the shape of two steel semi-cylinders lined with a two-inch layer of fiberglass sound-proofing material. Planes to be tested are wheeled backward between the cylinder shells. When in position, the plane's tailpipe fits into the Maxim silencers, a 38 ft tube extending back from the tail and curving to a vertical vent. Besides absorbing noise, the new unit traps sound waves and diverts them upward through a longitudinal rudder slot.





(Left) Lightweight cabs with clear plastic sides and tops ride on track of moving rubber conveyor belts. Doors open and close automatically when alongside and leaving loading and unloading platforms. Cars, seating 10 passengers, pass platforms in continuous stream eliminating present "batch loading" and rush hour congestion. (Right) Entrance view to loading platform of the new conveyor belt subway system. Passengers walk onto moving platform belt and step into small cars (with astradome tops and doors removed to show detail) which parallel the platform in a continuous stream.

Conveyor Belt Subway Proposed by Goodyear

PLANS FOR a radically new passenger subway system, utilizing the continuous loading principle of the conveyor belt, have been submitted to the Board of Transportation of New York City to replace the present shuttle under 42nd Street between Times Square and Grand Central Station. Engineered by the Goodyear Tire & Rubber Company of Akron, Ohio and the Stephens-Adamson Manufacturing Company of Aurora, Illinois, this design is the result of more than three years of study.

The loading platform, upon which passengers walk directly at either end of the shuttle, is a moving belt six feet wide. Alongside this platform end of the shuttle, is a moving belt six feet wide. Alongside this platform and moving at the same speed is a continuous stream of lightweight passenger cars with transparent plastic sides and top, and automatically controlled doors. Twenty-five cars, each seating 10 passengers pass the loading platform every minute. Capacity may be increased by using larger cars or increasing the rate of flow along the loading platform.

Once past the loading platform, the cars move over banks of pneumatic tire wheels which accelerate them and carry them onto a high speed conveyor belt. The cars are slowed down at the other end of the conveyor by similar banks of wheels and passed to another belt moving at the same speed as the unloading platform. Passengers step from the cars to the unloading platform which is identical to the loading platform in construction, and walk off at the far end.

The moving platforms operate at half the average pedestrian pace or 1½ miles per hours. Between loading stations, the cars are speeded up to 15 mph by the banks of wheels and the main conveyor belts. At either end, the cars are turned on rollers by a large wheel and returned in the opposite direction on the endless track.

Among the advantages claimed for the belt conveyor subway system are its continuous operation feature eliminating present batch loading methods and relieving rush hour platform congesting; reasonable cost of installation and low cost of maintenance and operation.

The continuous shuttle system has a peak load capacity of 32,000 passengers per hour in each direction. Passengers will be delivered from loading to unloading platform in two minutes, compared with the present shuttle rush hour time of three minutes. Operating costs of the new system are estimated to be less than one-half of the present operating cost of the shuttle at peak load. The proposal is certainly an interesting one.

Reynolds to Manage Experimental Air Force Forging Plant

ADRIAN, MICH.—Reynolds Metals Company has taken over the management of the U. S. Air Force Manufacturing Method Pilot Plan at Adrian, Mich. The $20,000,000 government-owned and industry operated facility will be used for developing forging and extrusion techniques and the proving of theoretical designs. No actual production will take place in the plant under the contract with Reynolds, except in the case of an emergency. The plant is to be operated by Reynolds without fee or profit.

The facility is available to any industry or government agency wishing to do development work on processes of either military or commercial interest. A number of large manufacturing firms in the country have been taking their problems and testing them in the Adrian plant by renting the facilities of the plant for the time consumed in their experiments. For instance, Curtiss-Wright has been experimenting with the production of a hollow steel propeller by the extrusion method. Watervliet Arsenal is trying steel gun barrel extrusion.

In discussing why the Air Force is interested in the Manufacturing Methods Pilot Plant, the Air Materiel Command of the U. S. Air Force pointed out that advanced aircraft designs call for parts that can best be made by forging, especially from light metals. Forged parts have higher strength-weight ratios than cast parts. Besides, forging a part like a spar cap consumes less manpower and metal than machining several components and assembling them into the spar cap.

For example, the Germans initially produced a particular 33-ft spar cap, weighing 176 pounds finished, by ma-

chining it from an extruded section weighing 517 pounds. That is, they produced one spar cap and 341 pounds of chips at considerable cost in labor, metal, tools and floor space. Only 22 pounds had to be removed from the 198 lb forging.

Uranium Ore Plant Near Cincinnati

THE UNITED STATES ATOMIC ENERGY COMMISSION will construct a uranium ore refinery and other facilities for the production of uranium feed materials on a 1,200 acre site near the Miami River, 19 miles northwest of downtown Cincinnati, Ohio. The new installation will produce uranium in forms suitable for use in the AEC's fissionable materials production plants.

The new facilities are being designed by Catalytic Construction Company of Philadelphia. Acquisition of the land will be undertaken by the Louisville (Ky.) District Office of the Corps of Engineers and construction will begin as soon as right of entry to the site has been obtained. Final selection of construction and contractors has not yet been made.

Exact boundaries of the site have not yet been determined, but it lies north of Fernald Station, Ohio, between Chesapeake and Ohio Railroad and US 50 (bypass).

In announcing the new site, Wilber E. Kelley, Manager of the New York Operations Office stated that no atomic weapons would be made at the site and that operations there would create no toxic or radiological hazards.

The Commission's feed materials production program has been described publicly as follows: "After the ore, once obtained, has been dried, crushed, and weighted, it goes to specially equipped plants for conversion into 'brown oxide' (UO_2) and simultaneous removal of impurities. The next step, also a complicated one, sees the 'brown oxide' converted into 'green salt' (UF_4). At this point the path branches, depending upon whether the material is destined for Hanford plutonium piles or Oak Ridge separation plants. In one case the 'green salt' must be reduced to metal billets, another industrial project of complexity; and the billets are then processed into 'slugs' of suitable size and shape for insertion in the Hanford reactors. If Oak Ridge is the terminal point, however, material in the 'green salt' stage becomes converted, again through special and large-scale plants, into uranium hexafluoride (UF_6). Such is the 'feeding' operation, one often neglected in public discussion although it engages an entire specialized segment of the nation's chemical industry."

The cost of the new Feed Materials Production Center is estimated to be at least $30,000,000. About 3,000 persons will be employed during the peak construction period; after, force of about 1,200 will be required.

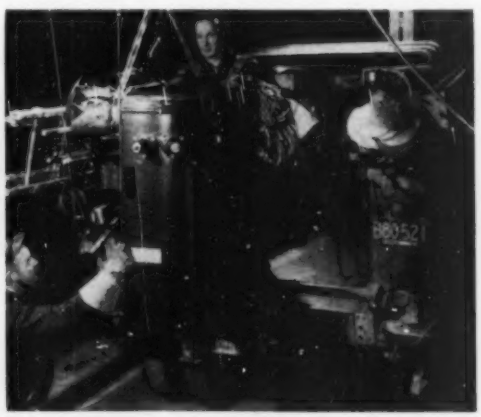
Another Corporation to Produce Titanium

IF THE RATE AT WHICH NEW COMPANIES are being formed for its production is any indication, titanium rates the raves that it has been getting as the wonder metal. Latest addition to the field is the Mallory-Sharon Titanium Corporation, a jointly owned endeavor of the P. R. Mallory Co., Inc., Indianapolis, Indiana and the Sharon Steel Corporation, Sharon, Pa. Objective of the new concern is "the development, production, and marketing of titanium and titanium alloys."

The Corporation will offer a series of proprietary alloys to meet the demands of various industries and, for the immediate future, the Armed Services.

The Mallory Company has been active in titanium research for the last decade and has done extensive development work for the Navy Bureau of Aeronautics on new titanium alloys during the last five years. Mallory is known for its pioneering efforts and accomplishments in the field of special metallurgy and has both research laboratory facilities and an engineering staff qualified to handle the titanium alloy project. A large amount of technical background has been accumulated in the melting, alloying and fabricating of titanium. Mallory has started to translate the results of these research activities into

MOBILE LABORATORY for lithographic reproduction of maps has been developed by the Army's Engineer Research and Development Laboratories at Ft. Belvoir, Va. Air conditioning and heating system maintains proper reproduction temperatures even at extremes as low as —70 F outside.



SPIRALCORE CONSTRUCTION, utilizing cold rolled grain oriented steel has been extended to three-phase transformers rated 150 kva and less, 15 kv and below, by GE. Use of this type of material is said to result in weight reductions as much as 30 percent in some instances.

pilot production by establishing production melting facilities.

Sharon Steel Corporation, a fully integrated steel producer, has facilities for rolling and further fabricating operations. This company has a keen interest in the commercial possibilities of titanium and its alloys. One of its subsidiaries, Niles Rolling Mill Company, Niles, Ohio, has gained rolling experience on large titanium sheets.

Needless to report the two companies feel that the combination of Mallory engineering and melting facilities with the Sharon Steel production experience and facilities provides a sound foundation.

How Tough Are Our War Sinews?

SINCE KOREA, the United States has demanded more from the citizens than ever before in peacetime. Object, to build up the nation and the non-communist west to challenge the Soviet Union.

Money for defense in the amount of $41.8 billion has been anteed up. More than $8 billions in new taxes have been levied. Business is being jacketed into materials and economic controls that already are hurting. And the nation's youth has been called.

What has the effort been worth in the 267 days since June 25? How much muscle has the regimen put on our military skeleton so far? And, what's the prospect for next year?

As of March 1, the total number of men and women in uniform was about 2,650,000. Here's the estimated breakdown:

	June 30, 1950	March 1, 1951
Army	592,000	1,400,000
Navy & Marines.	380,000	600,000
Air Force .	412,000	650,000

The Pentagon has announced that over 250,000 men are now in Korea. Probably another 150,000 are on occupation duty in Europe and Japan.

Quick Disconnect for Fighter Pilot Bailouts

DAYTON, O.—Engineers at the Air Forces' Air Materiel Command have developed a "rapid disconnect" to release the pilot from the plane during an ejection-seat escape from fighter planes. The various radio wires and oxygen supply leads have been combined into one 30-inch long rubber cable that can be separated from the plane when the ejection-seat lever is triggered.

During the pilot's bailout, a steel cable fastened to the cockpit floor holds the bottom half of the emergency disconnect rigid while the top half, including the tubing, remains attached to the seat. When the time comes for the pilot to leave his seat and use his personnel parachute for the rest of the drop, an automatic break called the "convenience disconnect" separates and the pilot finishes his descent free of all dangling wires.

A recent change in the technique of ejection seat bailout made a redesign necessary. Because the violent tumbling of the ejection seat during a long drop causes severe nausea, pilots will now separate from their seat almost immediately after they leave their aircraft and then free fall until they are low enough to use personal chutes to the ground.

The switch means transferring the oxygen supply from the seat to the airman's body where it would be available during the free fall. Thus the emergency oxygen supply connection had to be moved from the assembly emergency disconnect to its convenience disconnect.

The Aeroteck Corporation of Greenwich, Conn., manufacturers of the quick disconnect, have now almost completed the redesign and the device is expected to be standardized for all USAF high speed fighter planes in the near future.

Another recent development of the Air Materiel Command is a one-piece electrically heated flying suit to protect airmen in temperatures as low as — 65 F for well over 48 hours. The suit consists of an outer nylon shell, nylon inner lining, double faced wool pile interlining, a cotton interlining which carries resistance wires. A switch enables the wearer to give himself ⅓, ⅔ or full wattage; circuit arrangement permits shoes and gloves to receive normal current even if wattage to the suit itself has been reduced below full value.

PREVIOUSLY when a pilot bailed out of a fighter plane he first had to disconnect one at a time several wires and hoses; new development is a 30 in. long rubber cable that contains all the leads and separates from the plane automatically when the ejection seat lever is triggered. (Right) heated flying suit (complete with fur-lined parka hood for emergency use) will soon be keeping high-flying USAF airmen comfortable in temperatures as low as —65 F.

The remainder aren't all in the U. S. Other forces are on duty in the Mediterranean, Alaska, Panama, the Caribbean, Bermuda, Newfoundland, Labrador, England, Hawaii, Guam, etc. There are probably 1.8 million or more in the U. S. at present.

What the buildup amounts to is, 1. At least, Ridgway can be supplied reinforcements at a rate faster than losses through attrition or even another Chinese offensive: 2. The four divisions for western Europe that Eisenhower is supposed to get from the U. S. will be ready to ship out when the time comes.

Since the beginning of the Korean War, 10 Air National Guard Groups and four reserve wings have been called to active duty. Plans call for bringing in 12 more groups and 21 more reserve wings by May. By mid-year 1952, Gen. Vandenberg will have nearly 100 groups in the air.

Production since Korea has been mostly in combat planes—the jets, including the new Sabre F-86, as well as B-36 intercontinental bombers, the strategic arm that can deliver atom attacks if war comes. Production has gone from roughly 215 planes a month, to around 250 at the first of the year.

Aircraft capacity is being built up to a potential of 4,000 a month, in case of war. At the height of World War II, nine thousand planes were being made each month.

Procurement

The buying of hard goods constituted the major obligation incurred during the first seven months of fiscal 1951. Commitments reached $16.4 billion. Hard goods ran to $14.1 billion—clothing, subsistence, and petroleum products hit $1.5 billion—and military construction and expansion were around $800 million.

Of the $16.4 billion obligated, the AF took $6.7 billion; Army 6.3 billion; Navy 3.4 billion. Approximately $28.2 billion is available during the current fiscal year for procurement and construction. An added $3.6 billion is under the arms aid program.

Present rate of obligating, less day-to-day expenses increased over the planned program in January. According to schedule at that time, contract letting should have been around $3.5 billion for March. Latest estimates put the rate at nearly a billion more. Somewhere between $4 and $4.5 billion, per month. This brings the Defense Department closer to their schedule for a target date of June 1952.

Expenditures should hit $20 billion by the end of this fiscal year. But the rate of hard goods expenditures—and spending is a sound indicator of deliveries of munitions—is now at $800 million a month.

This does not include shot and shell—Ridgway has been supplied ammunition stored up since World War II. It doesn't include tanks. Except for some production of light tanks, procurement of new tanks still is in the mock up stage. Peak tanks production will come in late '52.

Ships

The Navy has put over 100 ships back on the line, approaching wartime strength. Congress is in the process of okaying a super-carrier, plus a host of auxiliary craft such as landing ships, tankers, and submarines.

Industrial Capacity

Industry already has added 4 million more tons of capacity since June 30, 1950, and 77 thousand tons of aluminum. Government expansion programs have been started on probably 10 million additional tons of steel, nearly 500 thousand tons of aluminum.

New capacity is being sponsored by the government for rubber, steel castings, metal extrusions, electronic gear, machine tools, and the like.

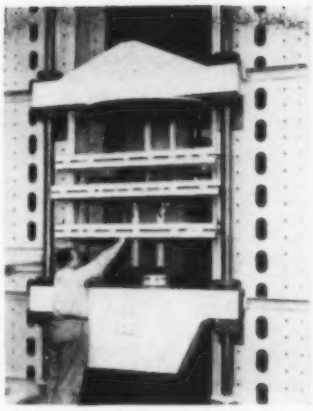
The record so far isn't bad. Recent signs of a letdown haven't had any effect on the plans put into operation last summer and fall. Whether the pace will fall off in the future depends on whether the administration counteracts the growing public apathy by letting the nation know its plans, and thus gaining support for future expenditures and commitments.

Torsional-Compression Testing of Aircraft Plate

NEW HEAVY PLATE CONSTRUCTION becoming more general in modern high-speed aircraft has necessitated development of new testing methods to study compression-shear interaction effects.

A new machine, designed by test engineers at Douglas Aircraft Co's El Segundo, Calif., plant and constructed by local foundries and machine shops, has now been put into use at the company's El Segundo Division test laboratory.

The machine can apply 2,500,000 lb compression load simultaneously with 10,000,000 in.-lb torsion to a specimen 5 ft in diameter and 14 ft long. Compression loads are applied



hydraulically through a three stage piston arrangement which permits a selection of piston sizes of 20, 100, or 500 sq in. capacity. The working pressure range is 1,000 to 5,000 psi giving a compression force range of 20,000 to 2,500,000 lb. Torsion is applied by two 100,000 lb capacity hydraulic jacks. The accuracy of these loads is within 1 percent.

The torsion feature of the machine is not shown on the photograph since it has been put to work on problems not requiring torsion before being completely assembled.

One Coat Paint Report Available

A REPORT COVERING two years of research on the Signal Corps' "One Coat Paint Project" is now available to the public, the Office of Technical Services of the U. S. Department of Commerce announced recently.

The report, prepared by the New York University College of Engineering for the Army's Quier Signal Laboratory, is divided into eight major parts: Basic research on the process of drying; drying paint films with light energy; the electrographic method for testing paint permeability; panel paint tests; improvements in the development and evaluation of coatings; improvements in laboratory equipment; studies on adhesion; and a bibliography on the chemical reactions in the formation and drying of coating materials.

Developments of particular interest include new findings on the solid phase of oils; drying tests conducted under ultra-violet light; new advances in electrographic testing methods to improve their adaptability to a wider range of problems; studies in the

use of catalysts to produce heavier paint coatings; and further experiments in the use of the new Epon resin coatings.

PB 101 680, "One Coat Paint Project: Eighth Quarterly Report", 222 pages including photographs, graphs and tables, is available from the Library of Congress Photoduplication Service, Publication Board Project, Washington 25, D. C. at $8 in microfilm or $28.75 in photostat. Orders should be accompanied by remittance payable to the Librarian of Congress.

Super Gage

NEW YORK—To control the thickness of hot-dipped tin coatings to within 6 ten-millionths of an inch, U. S. Steel scientists have combined two ultra-modern devices—the industrial X-ray and the Geiger counter. Measurement of the tin coating is made by exposing a sheet of tin plate to an X-ray beam for a short interval and, at the same time, measuring with a Geiger counter the secondary rays reflected by the steel beneath the coating. The tin traps some of the secondary X-radiation. That which reaches the counter is inversely proportional to the thickness.

In operation, measurements of coating thickness are made simultaneously on both sides of a plated sheet. The sheet is placed between two X-ray gages, a button is pushed to start the gages, and thirty seconds later the gages are shut off automatically. The precision readings of coating thickness are printed on moving tapes.

The net result is greater speed and accuracy than was previously possible with earlier chemical methods of measuring tin coatings and at the same time no marring of the surface.

Britain to Get New U. S. Patrol Bomber

BURBANK, CAL.—A new model of the Navy's P2V bomber, developed for anti-submarine warfare, has been announced by the Lockheed Aircraft Corporation. First of a substantial number of the new P2V-5 went to the U. S. Navy in April.

Concurrently, Great Britain and Australia have announced that they, too, will receive fleets of the P2Vs. Under a policy permitting release of certain key U. S. military equipment to friendly nations, special interest in the P2V also has been indicated by the governments of South Africa, New Zealand, Canada and the Netherlands.

This latest model, the P2V-5, continues the concept of aerial anti-submarine warfare explored and developed by the Navy and Lockheed in the P2V series. Their extreme long range permits the aircraft to roam far from shore and, with precise radar and electronic instruments, to intercept enemy intruders while they still are on the high seas. The special mission of the P2Vs is protection from ocean-borne attack, as that of the nation's newest, high performance interceptor fighters is defense against attack by air.

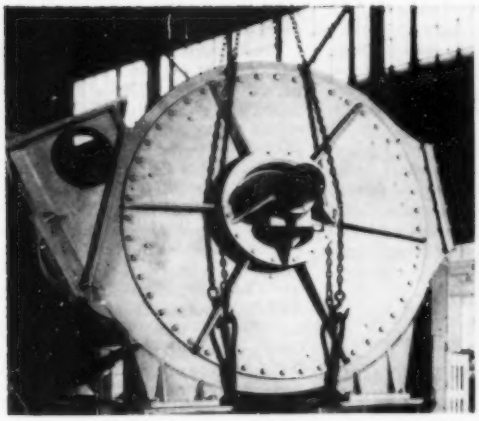
Purchase of the Lockheed airplane by England and Australia as well as by the U. S. Navy is regarded as a significant step in standardizing the weapons of the Allied nations.

This newest version of the P2V is distinguished externally from its predecessors by the addition of a nose turret armed with cannon, and by two tip tanks "center mounted" at the extreme end of the wings rather than slung beneath them. The P2V-5 carries appreciably more radar and electronic equipment in addition to its heavy armament than any previous model. Its range, speed and other performance characteristics are substantially the same as earlier types.

In its primary role of sub-killer, the P2V-5 can draw an exact bead with radar and sonobuoys. A pattern of sonobuoys dropped on the water will not only indicate position of the submerged sub but show its path of attempted escape. For the kill, the P2V drops torpedos.

With compound engines, latest model P2Vs extend their range still farther. P2Vs were the first production airplanes to adopt the powerful compound engines, which gain extra propulsion from otherwise wasted exhaust gases. The P2V is powered by two Wright R3350 engines.

NEWEST VERSION of the U. S. Navy's prime anti-submarine airplane is the P2V-5 announced jointly today by the Lockheed Aircraft Corporation and the U. S. Navy. Both Great Britain and Australia announced they will order fleets of this latest hunter-killer. Concurrently, a British designed Canberra light bomber—a speedy twin-engined jet bomber—is now at Wright Patterson Air Force Base in Dayton for evaluation by the U. S. Air Force and may soon be put in production by Glenn L. Martin. Wright Aeronautical also has British designed Armstrong-Siddeley jet engines ready for production. From all indications, British-U. S. exchange of engineering information and production know-how is proceeding at an unprecedented pace.



Bearing plates for these huge coal pulverizer exhauster casings are held in place by $\frac{7}{8}$ in. welded studs, which are capable of withstanding the excessive vibration encountered in the operation of this machine. This Combustion Engineering-Superheater pulverizer exhauster, which measures 6 ft 10 in. in diameter and weighs 118,000 lb, uses 48 of these large studs on each side of the casing. Larger diameter units require up to 64 studs on each side.

Combustion Engineering-Superheater and Nelson Stud Welding engineers have devised a simple but effective means of assuring positive stud alignment. Proper location of the stud is determined by a center punch mark, into which fits the pointed end of the granular flux-filled Nelson stud. When the gun and stud are in proper alignment, the ends of the set screws on a special adapter are pressed against the inner surface of the casing to locate the studs on the bolt circle. A tripod effect is obtained.

Stud Welding Extended to Larger Sizes for Combustion Equipment

CHICAGO, ILL.—Some of the largest diameter studs yet used for stud welding are currently being applied at the East Chicago, Indiana plant of Combustion Engineering-Superheater, Inc. in the fabrication of coal pulverizer and steam generator components. Both the welding equipment and studs were developed by the Nelson Stud Welding Division of Morton Gregory Corporation.

Fabrication of large units used in steam and power generating stations requires an extensive amount of assembly work in fastening portions of the machinery together to form a finished product. Since many of the components are large and unwieldy, any fastening method which speeds assembly operations is particularly advantageous—provided the fasteners can withstand the strains and vibrations to which the equipment is subjected.

Cover plates for the exhauster casings of coal pulverizers are held in place by as many as 64-$\frac{7}{8}$ in. end-welded studs on each side of the casing. Smaller casings with a 6 ft 10 in. dia, such as those shown in the accompanying illustrations, use 48 studs on each side.

Substantial savings have resulted on this operation. Originally, the casings, which are approximately one inch thick, were drilled and tapped. It is estimated that the drilling, tapping, and stud setting method required between 2 and 4 minutes, as compared with 20 seconds for each stud welding operation.

Seventy-two studs, in four different sizes, are used on a coal pulverizer separator top. Studs of $\frac{1}{4}$ in. diameter are used to secure the segment for the operating vane. The inspection cover for the separator top is held in place by $\frac{1}{2}$ in. studs, while each of the access doors are secured by $\frac{3}{8}$ in. x 2 in. end welded studs. Eighteen $\frac{3}{4}$ in. diameter standard studs secure the inner cone plate and rings to the separator top. Location is by template and punch mark.

Process in European Plastic Molding Equipment

DARMSTADT, GERMANY—In Europe as in America the plastics injection molding industry has entered upon a period of tremendous expansion since the war. New larger injection machines of up to 16 oz are becoming commonplace and machines of up to 60 oz capacity are expected to be in operation soon. The heavy predominance of small 1 to 3 oz molding machines which can be operated in Europe due to relatively low labor costs is gradually being reduced.

This change to larger molding machines and larger molded pieces has placed many new demands upon the European molding powder manufacturers. Requirements, especially in styrene, for greater color uniformity, improved lubrication and mold release, and greater heat stability appeared from many molders who had installed greater capacity equipment. American molding powder suppliers who had already been forced to solve these problems for their domestic market were well equipped to deliver grades of material which easily met the tighter and more stringent specifications.

During the past year considerable progress has been made to bring the quality of European thermoplastic molding powders up to the new requirements. The establishment of European plants owned by American manufacturers, plus the granting of process licenses by American producers to European companies has given additional impetus to the development of improved materials, and speeded the equalization of the stages of technical development between the two continents. At the same time, greater demand, plus difficult deliveries from America, have given much momentum to European molding powder plant expansions, and new plant constructions. In addition, smaller reprocessors of plastic scrap

are beginning to find opportunities in the market, and are beginning to do custom coloring and efficient large scale reclaiming of scrap material.

In these developments new extruder-compounding machines have played an important role. The European developments in this line differ slightly from those in America. Abroad, extruder installations can roughly be divided into two groups.

1. Installations of large material manufacturers where such extruders are used as compounders for only one type of material.
2. Installations of smaller material processors who use one machine to extrude different materials, and possibly also widely different shapes.

Thus, a demand has been created for two widely different machines. For the first group, machines specialized for only one particular material are demanded. Such extruders are generally geared to operate at one speed only, and have a screw, and heating zones along the cylinder designed for the particular needs of this one material. The smaller processors who use one machine for more than one material demand an extruder with maximum flexibility. It must be designed to come apart easily for thorough cleaning, and must be able to operate over a wide range of temperatures and speeds. In view of the fact that an extruder is basically a simple machine, consisting in essence of only a cylinder and a screw, many European processors have found it economical and practical to develop and build their own machines. Some of these appear to be almost exact copies of American models with only minor modifications.

Next Stage: Atomic Powered Aircraft?

WASHINGTON—The U. S. Air Force and the U. S. Atomic Energy Commission recently announced that the NEPA Division of the Fairchild Engine and Airplane Corp. has completed its contract for studies in the field of the development of a nuclear-powered aircraft. The NEPA Division has carried out experimental work at Oak Ridge, Tennessee, for over four years as a basis for a number of special reports required by the Air Force, the Atomic Energy Commission, and the Navy Bureau of Aeronautics.

Other projects being supported by AEC and the Air Force in the field of nuclear-powered flight will be continued. A group of leading aviation engine manufacturing companies has participated in the research under contracts with the Fairchild Engine and Airplane Corp. The following companies are in this group: Allison Division, General Motors Corp.; Continental Aviation and Engine Corp.; Frederic Flader, Inc.; General Electric Company; Lycoming Division, AVCO Manufacturing Corp.; Northrop Aircraft, Inc.; United Aircraft Corp.; Westinghouse Electric Corp.; Wright Aeronautical Corp. In addition, several industrial research laboratories and distinguished scientific consultants were associated with Fairchild in the work at Oak Ridge.

Observers attach considesable significance to the fact that, on completion of the NEPA contract, the Atomic Energy Commission started negotiations with G.E. to build a nuclear reactor engine for aircraft. It appears that the theoretical problems have been solved. But the practical problems remain, and they may prove by far the more difficult.

FIRST TEST of a new Naval Ordnance Laboratory temperature chamber was made recently when a Navy mine was given pre-production tests. The test consisted of taking the temperature chamber down to —65 F while test personnel checked working parts of the mine, then submerging the mine in normal temperature sea water to observe effect of dropping from cold upper atmosphere into the ocean. The test chamber can produce temperature range of from 200 to —100 F with any required degree of humidity. Test personnel can work inside the chamber in Arctic clothing, communicate with outside—and warmer—observers by telephone.

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NEOPRENE, the synthetic rubber made by Du Pont, can now be applied as an airdry protective coating for industrial maintenance work on structural steel, concrete, wood and exterior surfaces of tanks and equipment. It is applied by brush or spray gun in a single coat of 5-10 mils thickness. Outstanding properties are those which distinguish neoprene from natural and other synthetic rubber—exceptional resistance to oil, grease and chemicals; resistance to age-cracking by sunlight, weather and ozone. The new material is produced by Gates Engineering Company, Wilmington, Delaware.

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AMERICA'S FIRST INTEGRATED PRODUCTION PLANT for supersonic guided missiles has been activated as a new division of Consolidated Vultee Aircraft Corporation under contract to the United States Navy's Bureau of Ordnance. The first production project for the new division involves a supersonic anti-aircraft missile for the Navy's Bureau of Ordnance. All details of the weapon's design, performance and delivery rate are highly classified.

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BRITISH "SAPPHIRE" ENGINES, now in production at the Wright Aeronautical Corporation, will soon be installed in a new version of the Republic Thunderjet, the F-84F. The Sapphire which is rated at 7200 lb of thrust is the most powerful turbojet engine known to be in production anywhere. It features low fuel consumption, light weight, small frontal area and fewer critical materials than any other engine of its type. Its output will give the F-84 an additional 2,000 lb of thrust and improved performance on all points. The U. S. Air Force is also considering the Sapphire as the power plant for the Canberra, an English designed light bomber that may be made in this country by Glenn L. Martin.

•

THE USE OF RADIOISOTOPES IN INDUSTRY is the subject of a conference scheduled at Iowa State College, Ames, from 1-3 May 1951. The conference, which is open to all interest individuals, is sponsored by the Engineering Extension Service in cooperation with the Institute for Atomic Research at Iowa State College. Details are available from Dr. Glenn Murphy, 101 T. & A. M. Lab., Iowa State College, Ames, Iowa.

•

INDUSTRIAL USES for radioactive by-products of the atomic energy program are being investigated by the Stanford Research Institute for the AEC. Industrial concerns will be acquainted with the characteristics of fission products to speed estimates of their possible utilization.

•

CIRCUIT DIAGRAMS and production

Servomechanisms Courses at MIT

THE THEORY AND APPLICATIONS of feedback control systems (servomechanisms), and the broad concept of "system engineering", will be the subject of a special course during Summer Session 1951 at the Massachusetts Institute of Technology, from August 20 to 31.

The course will include a survey of the theory of feedback systems with emphasis on dynamic operations and system synthesis. Industrial applications of feedback control systems, or servomechanisms, in such diverse fields as steel making, printing, petroleum processing, wood working, textile manufacturing, chemical processing, and power distribution will be discussed.

Following morning lectures, demonstrations and laboratory work in afternoons during the course will make use of the student laboratories in the electrical engineering department. Measurement of system and component performances and methods of testing and evaluating process control equipment are to be included in the laboratory program.

Intended for engineers with a background in the problems of industrial engineering and production management, the course will be open to those who have had no previous acquaintance with the servomechanisms field, though a familiarity with the engineering problems to be discussed will be helpful.

Further information on this and other special summer activities may be obtained from Professor Gale at Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

Bendix Isotope Reactor Under Study

THE ATOMIC ENERGY COMMISSION and the Bendix Aviation Corporation, Detroit, have started discussions of a Bendix proposal to undertake a privately-financed feasibility study of a nuclear reactor to produce radioisotopes on a commercial basis. The Commission's action is in line with its previously announced policy of encouraging wider industrial participation in reactor developmental phases of the national atomic energy program.

Under this policy the Commission is undertaking cooperative activities with industrial concerns to explore the possibilities for their participation —on their own initiative, using their own resources—in development of commercial applications of atomic energy. The Commission's cooperation in such investigations will be extended so as to insure:

1. Maximum attention to the atomic energy production program in all its phases,
2. Special effort on those matters that will be productive in the relatively near future (one to three years),
3. The application of the best available brains to all the important problems in the atomic energy program.

The Commission now has before it proposals from industrial groups or firms for studying the practicality of designing and building materials-power producing reactors and for studying the developing industrial uses of radioactive fission products. In each case the firm has suggested that it carry out the study phase with its own personnel and funds, the Commission being expected to make available pertinent information.

---

specifications for an inexpensive, easily-operated Geiger-Mueller counter appeared in AEC Document NYO-1538. The counter is powered by two 1½ volt flashlight batteries and weighs only 1¾ pounds. One model measures radiations up to 500 roentgens per hour and the other measures low level radiation with a maximum range of 5 roentgens.

•

DUPONT'S PROGRAM for providing one year of industrial experience for engineering college educators was inaugurated with the selection of Dean David L. Arm of the University of Delaware as the first candidate. Additional appointments are expected soon.

•

FASTEST AND MOST POWERFUL SINGLE-ENGINE, prop-driven training plane, the new TF-51 Mustang, is a fully engineered conversion model of the well-known fighter incorporating major structural and instrumentation design changes.

•

AEC TEST PROGRAM at the Eniwetok Proving Ground include measuring the effects of atomic weapons on structures and structural materials. This information will be made available to the Civil Defense Administration.

•

BELLY LANDINGS have been made by many pilots in times of emergency, but the procedure is not generally recommended as a desirable one. However, a new carrier-based British fighter has no landing wheels, but lands on its belly on a rubber mat on the carrier's deck.

•

LOCKHEED'S new weather chamber will test aircraft materials and components under conditions found up to 75,000 feet. Temperatures from —100 to —600 F and all possible weather combinations including salt water immersion will also be possible.

•

REFLEX RESNATRON, a war-born electron tube once used to jam German radar, is now being groomed by Westinghouse scientists to serve as a high-power transmitter for color television. It promises greater range, better reception and more TV stations possible in the same space.

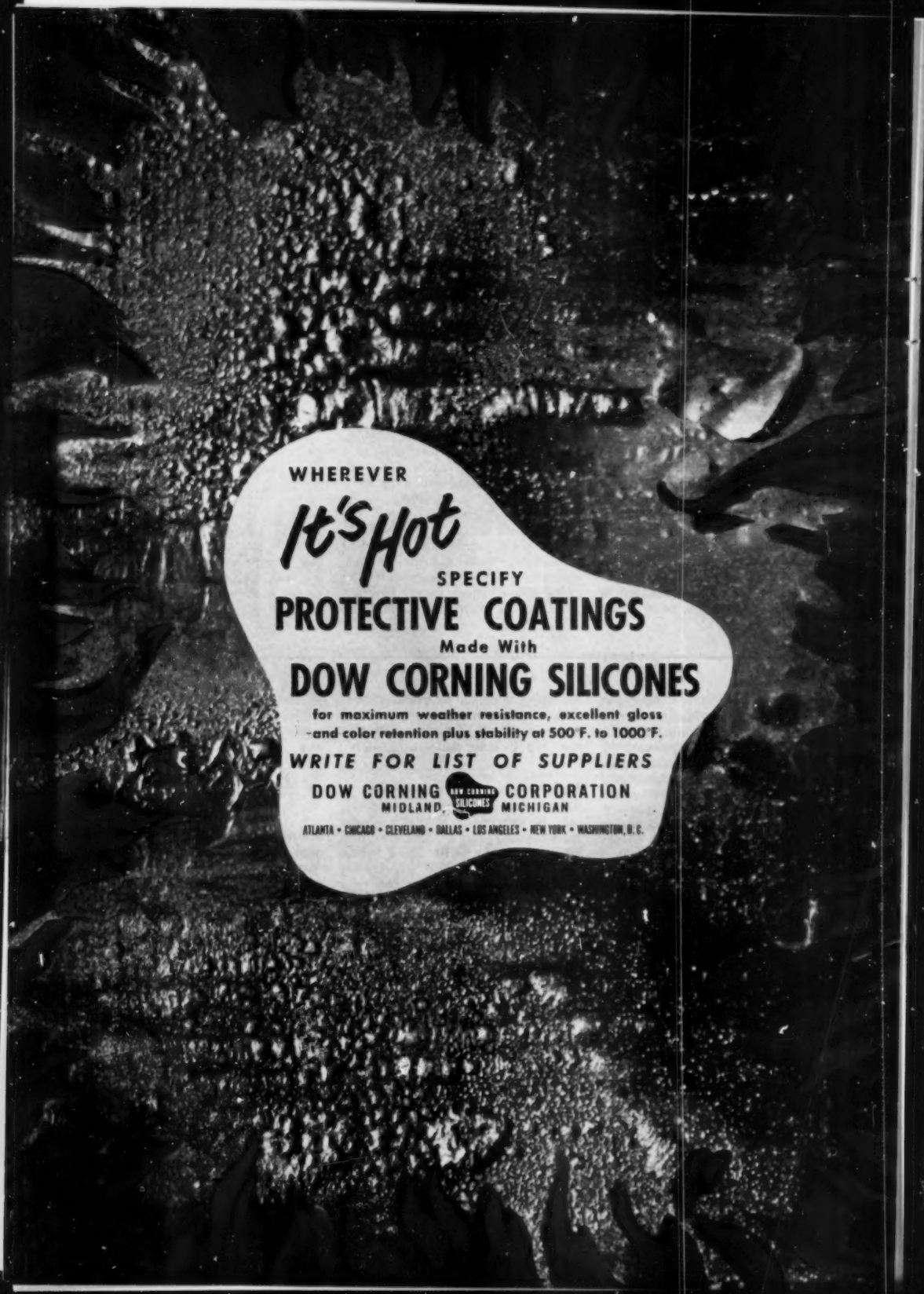
NATIONAL BUREAU OF STANDARD scientists through spectroscopic investigations have positively identified two new artificial elements, technetium (tc) and promethium (Pm). Not found in nature, they are by-products of uranium fission.

•

A NEW TYPE DUAL PURPOSE BUS designed by the Army Ordnance Corps carries 37 passengers, but can be converted in less than 45 minutes to an ambulance with capacity of 21 stretchers. The vehicle is equipped with folding type seats, resembles an ordinary inter-city bus with exception of twin rear doors to facilitate moving of casualties.

•

A GAS-TURBINE POWERED BOAT is being tested at the Naval Engineering Experiment Station, Annapolis, with speeds up to 21 knots from the 175 HP, 200 lb Boeing designed engine. The turbine has a rated speed of 24,000 rpm, drives through reduction gears which give a propeller speed of 2500 rpm. The engine takes up only 13 percent of the space occupied by its diesel equivalent, will start and attain full speed in seven seconds.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Made With
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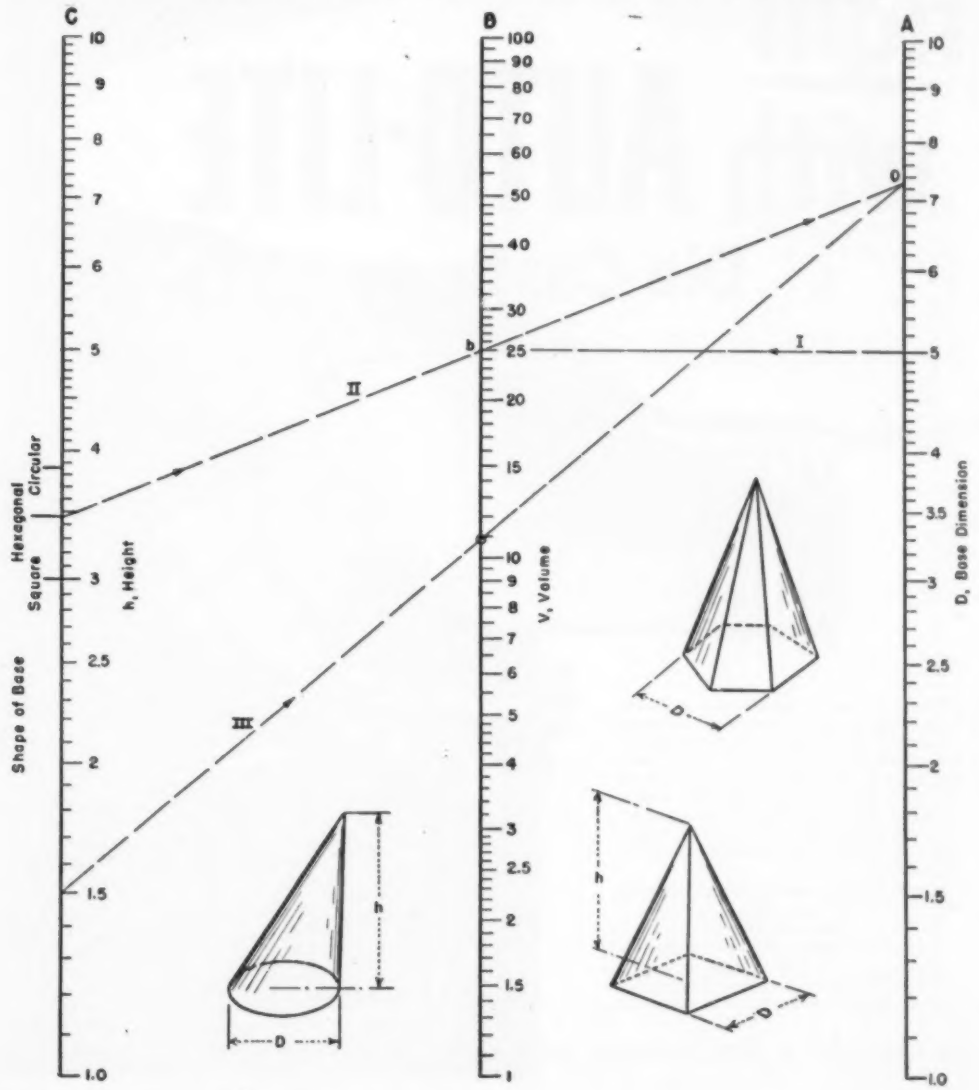
Nomograph for the Volume of Cones or Pyramids

CARL P. NACHOD, NACHOD AND U. S. SIGNAL CO., INC.

COMPUTING the volume of cones or pyramids can be simplified by use of this chart. It applies to shapes which are either right regular or general, with the apex off-center. Frustums of a cone or pyramid can be calculated by subtraction. Although scales *A* and *C* are limited to 10 units, they can be used for larger values if the dimensions are divided by a factor of 10. However, the volume read on scale *B* must be altered to compensate for this.

EXAMPLE: Find the volume of a hexagonal pyramid: Base dimension, $D = 5$ in. and height $h = 15$ in. Draw horizontally line I from 5.0 on *A* scale to point *b* on *B* scale. From the *Hexagonal* point on *C* scale, draw line II through point *b* to point *O*. Draw line III between height $= 15/10 = 1.5$ on *C* scale and turning point *O*. This line indicates a value of 10.8 cu. in. which should be multiplied by 10 for the final volume of 10.8.



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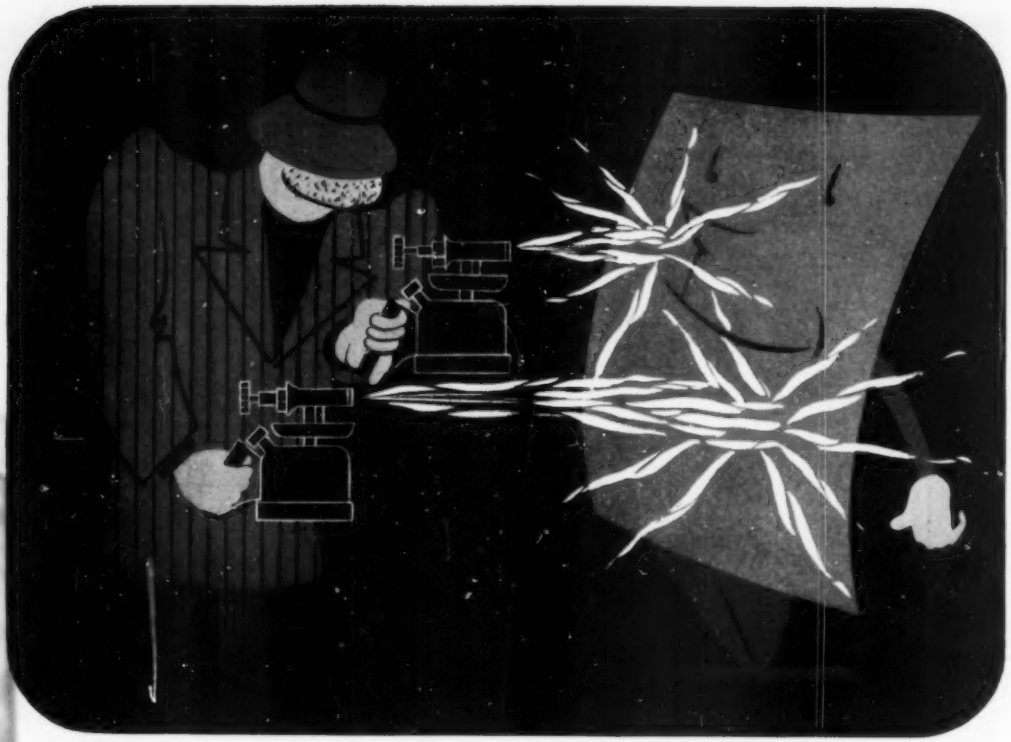
Corrosion Resistance of Typical Laminated Metals

GENERAL PLATE DIVISION, METALS & CONTROLS CORP., ATTLEBORO, MASS.

Metal or Alloy	Analysis percent	Condition	Ultimate Strength psi	Elongation per cent (2-in. gage)	Specific Gravity	Resistance to		Annealing Temp. Deg. F.	Room Temp. Corrosion Resistant Properties (See Note)																			
						HEAT	WEAR		Sulphuric Acid		Nitric Acid		Hydrochloric Acid		Acetic Acid		Sodium Hydroxide		Ammonia		Sulphur Dioxide	Sulphur	Fruit Juice	Phosphoric Acid	Ink	Sea Water
									D	C	D	C	D	C	D	C	D	C	D	C						
Platinum	99.95	Hard Annealed	36,000 20,000	3 35	21.45	Good	Poor	1300-1500																				
Gold	99.9 +	Hard Annealed	31,000 17,000	4.2 45	19.3	Good	Poor	800-1000																				
Yellow Gold	Au 58.5, Cu 30 Ag 5.5, Zn 6.2	Hard Air Cool Water Quench	130,000 83,000 70,000	3 36 40	13.0	Poor	Fair	1000-1200				*																
White Gold	Au 58.5, Cu 24 Zn 5, Ni 12.5	Hard Annealed	144,000 100,000	3 29	13.2	Fair	Good	1250-1400																				
Palladium	99.9 +	Hard Annealed	47,000 30,000	24 40	11.96	Good	Poor	1400-1600																				
Silver	99.9 +	Hard Annealed	38,000 25,000	5.5 55	10.49	Fair	Poor	1000-1150																				
Nickel	99.4	Hard Annealed	100,000 70,000	2-8 43-53	8.85	Good	Good	1200-1500																				
Monel	Ni 67, Cu 30 Fe 1.4, Mn 1.0	Hard Annealed	110,000 70,000	2-8 35-50	8.80	Good	Good	1300-1600																				
Sterling Silver	Ag 92.5 Cu 7.5	Hard Annealed	63,000 40,000	8 35	10.3	Poor	Good	1100-1250																				
Copper	99.9	Hard Annealed	55,000 35,000	5 35	8.93	Poor	Fair	800-1100																				
Iron	99.95	Hard	44,000	25	7.86	Fair	Fair	1200-1500																				
Nickel Silver	Ni 18, Cu 65 Zn 17	Hard Annealed	95,000 58,000	2 33	8.75	Fair	Good	1100-1300																				
Gilding Metal	Cu 90, Zn 10	Hard Annealed	65,000 37,000	1 40	8.80	Poor	Fair	1000-1200																				
Bronze	Sn 2, Zn 7, Cu 91	Hard Annealed	72,000 43,000	1 50	8.60	Poor	Good	1100-1250																				
Chrome Steel	Cr 16, C 0.1	Hard Annealed	95,000 75,000	25 30	7.67	Good	Good	1500																				
Chrome Nickel Steel	Cr 18, Ni 8.5 C 0.12 max.	Hard Annealed	100,000 80,000	50 65	7.86	Good	Good	2100 Quench																				

Note: Good Resistance to Solutions; Generally resistant but dependent on certain conditions; Poor resistance and not recommended

D = Dilute Solutions; C = Concentrated Solutions; * Tarnishes only



Heat's on!

That's like a "soup's on" signal for Armco ALUMINIZED Steel—the aluminum-coated sheet steel that is at its best at temperatures between 300 and 1250 F. It gives your products good resistance to a *combination* of heat and corrosion.

Generally, aluminum melts at about 1200 F. But you'll find the hot-dip aluminum coating on ALUMINIZED Steel doesn't melt off at its melting point!

Seems strange, doesn't it? But there's a good reason:

An iron-aluminum alloy starts to form above 900 F. It serves as a good refractory layer up to 1250 F. By its conversion to an alloy the aluminum puts up a protective "fire wall"; the steel core supplies the strength.

Heat reflectivity is excellent up to 900 F. About 80% of the radiant heat sent against the surface of Armco ALUMINIZED Steel *bounces back*.

Even if you can't include this Armco Special-Purpose Steel in your present plans, it will pay you to have complete technical and merchandising information for the day when it is more plentiful.

More Scrap Means More Steel!

Without more steel scrap, maximum steel production is *impossible!* New furnaces built by the industry cannot be operated at capacity with the present scrap supply. Help us help you. Sell your scrap . . . *today.*

ARMCO STEEL CORPORATION

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ARMCO

Oil Selection Chart

H. W. HAMM
Design Engineer, S. Morgan Smith Co., York, Pa.

MEDIUM AND LIGHT LUBRICATING OILS

Commercial Designation	Viscosity	General Description	Application
E. P. Hypoid Gear Lubricant or Universal Gear Lubricant (for very cold climates)		Gear oil, containing extreme pressure (E. P.) additives to maintain lubrication under extreme pressure conditions	For all gear lubrication in cold climates where the prevailing temperature is below zero F.
S.A.E. 90 E.P. Hypoid or Universal Gear Lubricant	75 to 105 SUS at 210 F.	Same as above except Viscosity	As above except for use where the prevailing temperature is above zero F.
S.A.E. 80 E.P. Hypoid or Universal Gear Lubricant	60 to 70 SUS at 210 F.		As above except for use if the prevailing temperature is between zero and 32 F.
S.A.E. 10	90 to 120 SUS at 130 F.	Heavy Duty Lubricating Oil	For General Purpose Lubrication
S.A.E. 20	120 to 145 SUS at 130 F.		
S.A.E. 30	185 to 280 SUS at 130 F.		
S.A.E. 40	75 to 90 SUS at 210 F.		
S.A.E. 50	90 to 105 SUS at 210 F.		

RECOMMENDED S.A.E. OILS

Application			Operating Temperatures in Degrees Fahrenheit	S.A.E. Number
Sleeve Bearings*			100 to 130 130 to 145 145 to 165 165 to 180 Above 180	10 20 30 40 to 90
Thrust Bearings* Shoe, Pivoted or Solid Type			130 to 150	30
Ball and Roller Bearings	Pitch Line Speed—fpm			
	to 300		Below 32 32 to 150 150 to 200	10 W, 10 30, 80 60, 140
	300 to 750		Below 32 32 to 150 150 to 200	10 W, 10 10, 20 30, 80
	Over 750		Below 32 32 to 150 150 to 200	10 W, 10 10, 20 10, 20
Hydraulic Power Systems			Below 32 32 to 150 150 to 200	10 W, 10 10, 20 30
Enclosed Gear Drives			0 to 40 40 to 100 100 to 160	30 40, 90 50, 90
Open Gears (see grease chart also)			0 to 40 40 to 100 100 to 160	30, 50, 90 50, 90, 140 60, 140
Chain Drives			0 to 40 40 to 100 100 to 160	10, 20 30, 80 50, 90
Flexible Couplings (Gear type)				140
Electric Motors		HP Rating		
	Sleeve Bearings*	Below 75	75 to 100 100 to 140	10, 20
		Above 75	100 to 130 130 to 165	10, 20, 30
	Ball Bearings		Below 32 Above 32	10 20, 30

* Operating temperature in this case refers to the oil-film temperature.

This data is based on U. S. Navy Bureau of Ships Manual

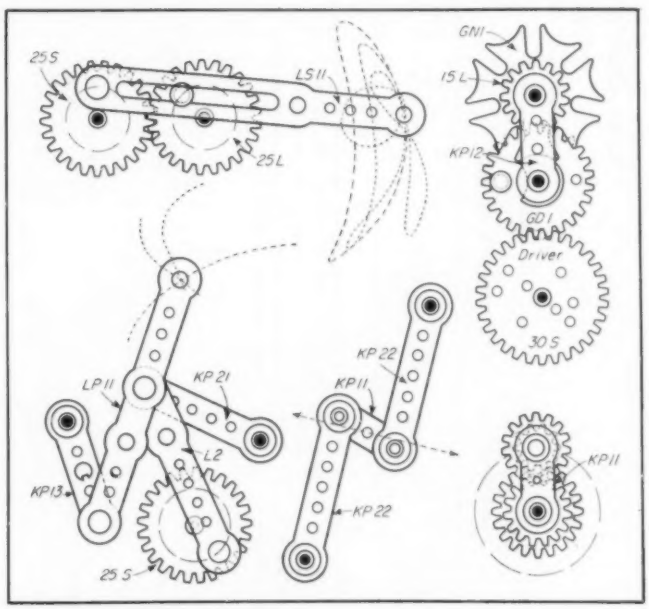
Now Designer Can See His Ideas in Action

Product development and design of machines, instruments and devices involve, in many cases, complex kinematic chains or interconnection of various mechanisms. The layout of these, even though they may be simple, and the plotting of their paths of action are both tedious and time consuming. This task can be simplified, it is said, by providing the design section with a set of interchangeable mechanical elements that can be assembled into mechanisms with reciprocating, straight-line, oval, irregular, transfer, intermittent, geneva, planetary, differential, harmonic, computing, skip-stop, forward-reverse, and many other motion patterns. These mechanisms can then be studied on the drawing board and can be altered or combined in various ways.

Two sets of these mechanisms are available. The smaller consists of 65 aluminum transmissions elements, 120 aluminum fastenings, 300 screws, 300 push fit fastenings, a 12 x 14 in. perforated base board, frames, hubs and washers all positioned in a wood compartment case equipped with two trays. The layer consists of more of each of the groups of parts. The elements can be assembled into motion patterns by push fit or by screws and metal fastenings. Since any class fit can be secured, velocity diagrams and similar charts can be plotted accurately.

It is pointed out that models that cannot be altered, added to, or combined with others do not permit a trial and test of ideas. They perpetuate existing conditions. The models developed from these elements are not fixed; the almost endless changes that can be made provide an influence that stimulates the processes of innovation and that may lead to developments far beyond any original concept.

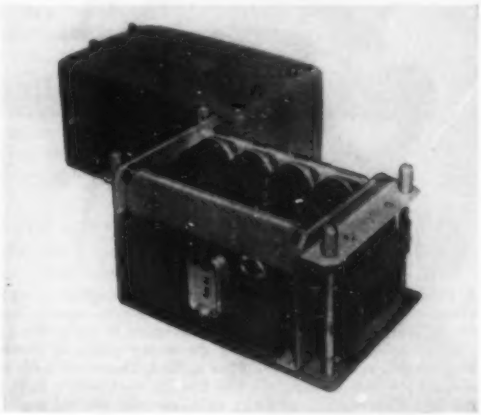
Techmotion Lab., Chartley, Mass.



Circle No. 1 on Reader Service Card

Packaged Servo Amplifier For Industrial Processes

An adaptation for industrial purposes of a 400 cycle type used in military equipment, this 60 cycle servo amplifier is a small plug-in unit in which all the electronic elements required for one function in a control system are packaged together. Functional packaging of the amplifier elements simplifies maintenance and training. Moreover, because the elements are packaged compactly it is easy to plug into a chassis with other servo units or to install in a small volume where space is at a premium. In conjunction with other control components, it can be used to position remotely and with accuracy a shaft in such equipments as analogue computing devices, laboratory measuring instruments and industrial process controls for various chemical processes and other continuous reactions.



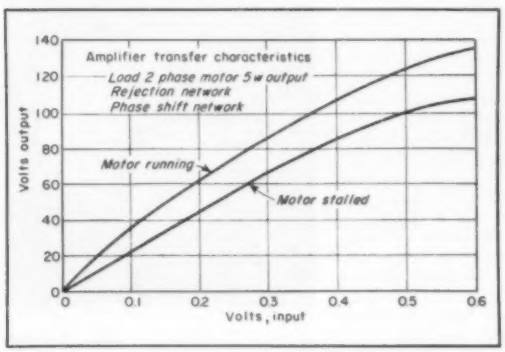
Intended primarily for use in high performance velocity or position servo loops, the amplifier contains electronic circuits for the control of a 60 cycle, two phase servo motor of five watts mechanical power output. Additional plug-in facilities within the unit, comprising the transmission control networks, permit the adaptation of the amplifier to widely varying requirements for gain, phase shift and damping. Therefore, it may be used in many different applications, with a common stock of spares required for all uses. The net gain is dependent upon the choice of rejection and phase shift networks. Two of these, the gain characteristics of which are shown in the accompanying graph, are used in the majority of applications. However, for low response conditions or velocity servos requiring tachometer data systems, a resistive network that gives a net gain of 4,000 is used instead.

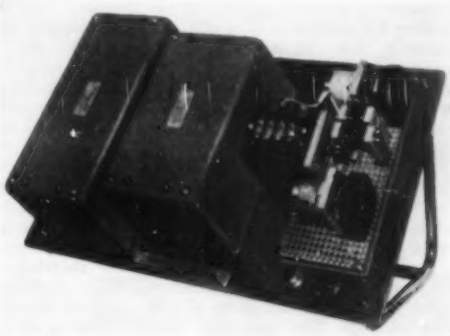
Error rate damping is furnished by a plug in the rejection network. Velocity damping for low response and velocity servos can be furnished by tachometer generators. Best operation for the amplifier in conjunction with the error rate networks is on carrier signals of 60 ± 2 cps.

The unit, which measures 5 in. in width, 8 in. in length, and 4⅜ in. in height, and weighs 5½ lb, is expected to be particularly useful to manufacturers of military equipment in developing control systems for accurate and automatic processing and inspection, essential to quantity production. It is also suitable to establish the requirements for new control systems before their actual design.

Servomechanisms, Inc., Old Country & Glen Cove Rds., Mineola, N. Y.

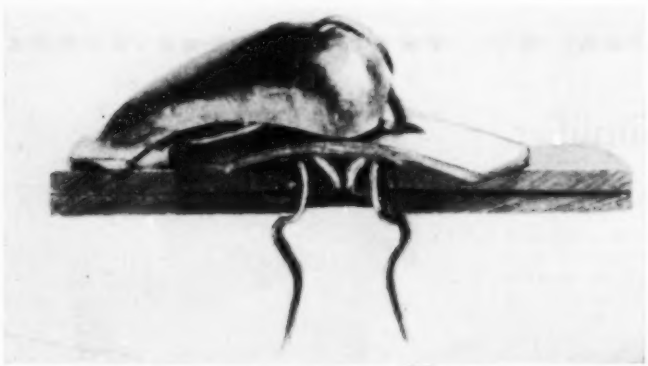
REMOTE SHAFT POSITIONER comprises servo amplifier and its companion power supply. Controlled shaft (upper dial) will follow controlling shaft (lower dial) with but little error under conditions of high acceleration and will hold a static position to fractions of a degree.





Circle No. 2 on Reader Service Card

CONTINUED ON PAGE 216



A PERMANENT FASTENER, Thumweld is designed to replace screws and bolts where speed of assembly is important or where parts must be disassembled occasionally for service or inspection. All that is necessary to apply this fastener is a drilled or punched hole. Into it are inserted the anchor points of the fastener which is then snapped shut with the thumb. When applied, Thumweld holds securely, it is said, and will not jar loose. It is released by flipping open with a knife edge or screw driver. Among its applications are duct work, aircraft, vending machines and many others.

Permanent Fastener Facilitates Assembly

Of interest to manufacturers fabricating or assembling sheet metal products is a small fastening device known as "Thumweld". It is for use as a permanent fastener where rapid assembly or disassembly is important or where parts such as access plates, radio parts, metal housings, panels, cable brackets and instruments are occasionally removed for inspection or maintenance or other purposes.

The fastener is inserted in a $\frac{3}{16}$ in. hole. Thumb pressure is sufficient to lock it in place. Once locked, it is said, the fastener grips as securely as a metal screw and will not jar loose. Loadings up to 15 lb can be accommodated although in cases of heavy vibration, a loading of 5 lb should not be exceeded. A pry with a screw driver or thumb nail releases it. These fasteners will be available for hole sizes ranging from $\frac{1}{8}$ to $\frac{1}{2}$ in. and for metal thicknesses up to $\frac{1}{4}$ in., it is claimed by the manufacturer.

American Shower Door Co., 1028 N. LaBrea Ave., Los Angeles, Calif.

Circle No. 3 on Reader Service Card

Actuating Mechanism Controls Gear Rack Movement

A simplified, 24 v d-c actuating mechanism has been designed for controlling the movement of a gear rack assembly used in aircraft control equipment. The unit can be adapted, however, to other applications, such as tripping mechanisms, switches and valve operations and can also be manufactured for other voltages, included 110 v a-c operation. Its spring design provides minimum pressure in the "open" or non-operating position, while furnishing maximum pressure in the closed position, for fast return.

Simple in construction, it requires no hinge pin or bearing mechanism which would need lubrication to prevent sticking. Life tests have been run in excess of 2,000,000 operations without any apparent wear in the components. The actuator is normally adjusted for approximately $\frac{1}{16}$ in. travel of the armature, but this is variable depending on voltage and pressure requirements. The assembly weighs 2 oz, and occupies a space $1\frac{1}{4}$ x 1 in. Mounting is made with two 6/32 in. screws.

This product is made by a new company which is said to be making rapid strides in the design, development and manufacture of components for electrical and electronic devices. Other products similar to this actuating mechanism are being developed by the same concern.

ETC, Inc., Niles, Michigan

Circle No. 4 on Reader Service Card

CONTINUED ON PAGE 218

Just One Catalog...CRANE

Gives All the Piping Specs

To take a case in point: suppose you're designing the *Steam Generator,* shown here. What's the quickest way to find all the valves, fittings, pipe and accessories you need? Turn to your Crane Catalog. It contains the world's most complete selection of quality piping equipment . . . helps cut specifying time to the minimum.

To rely on Crane simplifies all piping procedures. Ordering and storekeeping, for example, are greatly simplified when you can get everything in piping from a single source. Shop assembly goes smoother, too.

Most important to you, of course, is the added value your product acquires when all flow control equipment is Crane. Your customers know from experience that Crane Quality stands for the best in piping materials.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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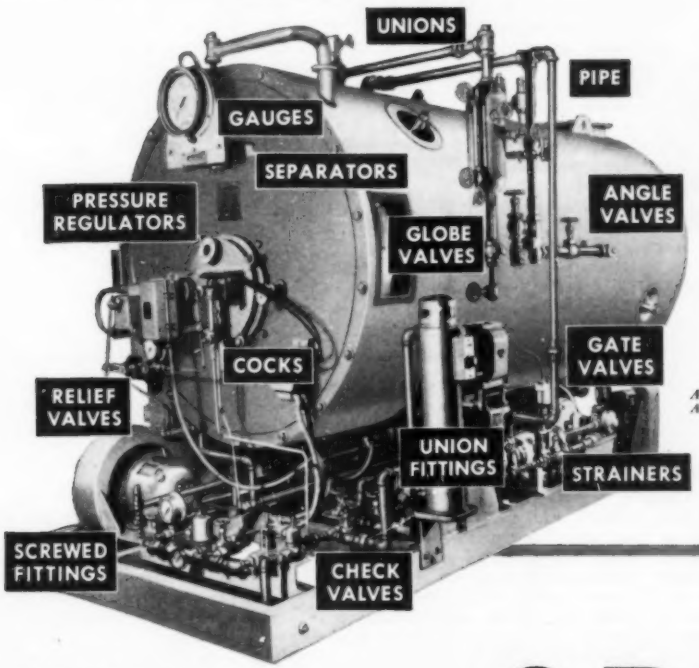


Amesteam Generator by Ames Iron Works, Oswego, N. Y

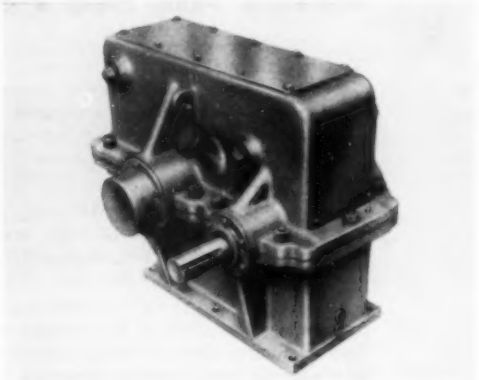
FOR THROTTLING **and other severe services such as blow-off, boiler feed, drip and drain lines, Crane recommends No. 16½P 150-Pound Brass Angle Valves. Crane alloy plug type disc and seat permit close regulation of flow; offer higher resistance to wire-drawing, corrosion, erosion, galling and scoring. Union or bolted bonnet, depending on size. Working pressures: 150 pounds saturated steam; 300 pounds cold water, oil, gas. Sizes: ⅛ to 3-inch. See your No. 49 Crane Catalog.**

EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

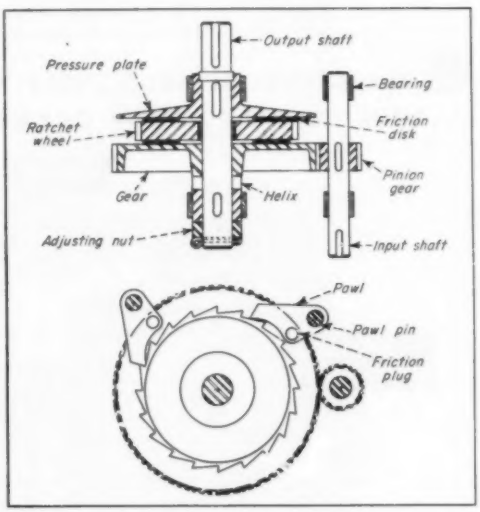
Loads Held Safely With Automatic Brake



This automatic mechanical load brake for cranes and other hoisting equipment provides a positive control on the lowering speed of the load without attention from an operator. Thus a suspended load will not overhaul the hoist motor and drop at a dangerous rate of speed. The brakes will also hold in any position independent of any other brake in the hoisting system. With a full load hanging from the hoist the hoist motor may be disconnected and removed without danger.

The brake is of the Weston type (two disk construction), helix operated, and is built into the second or low speed shaft of the assembly. The load is kept from lowering or running down by two pawls in contact with a ratchet wheel. The weight of the load acting through a helix produces an axial thrust which clamps the ratchet wheel between two friction disks with sufficient pressure to prevent all rotation in the lowering direction. By operating the hoist motor in the lowering direction, the pressure on the helix is relieved and the brake opens, allowing the load to lower. The opening of the brake is in direct proportion to the load, and just sufficient to permit the load to lower under direct control of the motor, and at motor speed. Since the motor exerts power to hold the brake open and drive the load downward, the load cannot overhaul the hoisting mechanism. When the hoist is operated in the upward or lifting direction, the pawls lift clear of the ratchet wheel by means of friction plugs, and the entire mechanism runs free. The brake housings are oil tight, and the entire mechanism operates in oil. This is said to insure proper lubrication and an abundance of oil for dissipation of frictional heat generated during the lowering cycle.

For close control and accurate spotting of the load, a holding brake should be used on the motor shaft to overcome rotor inertia and bring the motor to a quick stop after the current is cut off.



Downs Crane & Hoist Co., 540 W. Vernon Ave., Los Angeles, Calif.

Circle No. 5 on Reader Service Card

Coatings Protect Against Corrosive Fluids

Now being produced in quantity after being field tested for a number of years are a group of coal tar base, anti-corrosive coatings for the protection of metals, wood, masonry and insulation. They are claimed to form a tough elastic film that resists the penetration of chemicals, fumes, moisture and heat. Moreover, they are insoluble in oil and waterproof. They resist such inorganic acids and alkali as sulfuric acid and caustic potash, as well as offering protection against alcohol, formaldehyde, salt spray, and a wide variety of organic acids.

Since other wear conditions are often present along with corrosive influences, three of the coatings have been formulated to meet corrosive conditions in combination with various abrasive actions, heavy vibrations, extreme contractions and expansions. No primer is needed. Protection is in direct proportion to film thickness and the number of coats applied. Applications include air ducts, condenser coils, cranes and many others.

All coatings are adaptable to conventional methods of application, and some withstand heat up to 600F.

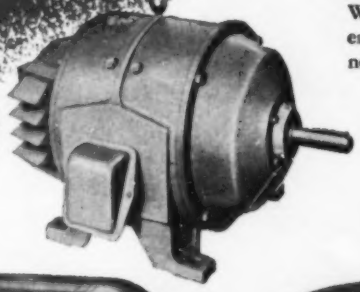
Continental Coatings Corp., 304 W. 44th St., New York, N. Y.

Circle No. 6 on Reader Service Card

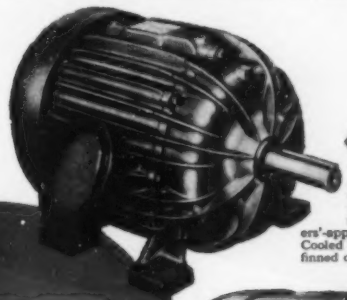
CONTINUED ON PAGE 221

Motors like these build CONFIDENCE in your product!

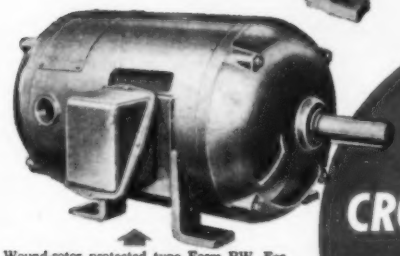
Select a motor that enjoys national acceptance, plus recognized quality. You'll find it in this complete line of integral motors from 1 hp up, with the backing of both Crocker-Wheeler and Elliott. Get double assurance of superb motor engineering and workmanship, and enjoy the speedy, top-notch service of an organization geared for fast action. Write.



Totally enclosed and drippproof protected types Form F, in ratings to 7½ hp. Form H, 10 to 200 hp.



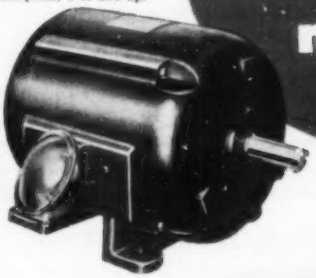
"Sealedpower" totally-enclosed fan-cooled squirrel-cage motors, 3 to 125 hp. Also explosion-proof underwriters'-approved, 20 to 125 hp. Cooled by air blown along the finned outer case.



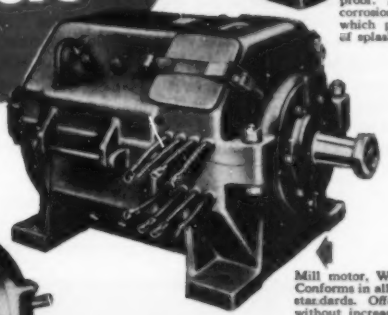
Wound-rotor protected type Form BW. For slow, smooth acceleration, high starting torque with low starting current, or variable speed. Drip-proof, splash-proof, 1 to 200 hp.

ELLIOTT
CROCKER-WHEELER
Integral
motors

Squirrel-cage splash-proof. Form BA. Has corrosion-resistant covers which prevent entrance of splashing liquids.

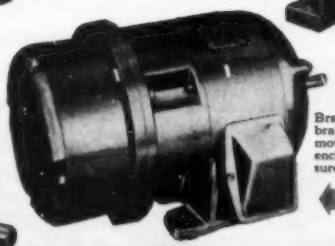


Squirrel-cage, totally enclosed, non-ventilated Form BE. Available up to and including 3 hp at 1800 rpm, for applications requiring protection against dust, fumes, moisture.



Mill motor, W600 Series, DC. Conforms in all respects to AISE standards. Offers more power without increase in frame size.

Squirrel-cage protected type Form BA. An open drippproof motor for general purpose use. Available in wide modifications to meet a variety of conditions.



Brake motor using latest disk type brake mounted on BA drippproof motor. Also available with totally enclosed and splashproof enclosures for AC or DC applications.

Above is a partial showing of the complete line. For descriptive bulletins, address Elliott Company, Dept. P.E., Jeannette, Pa.

CW-28

ELLIOTT COMPANY
Crocker-Wheeler Division · Ampere, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

C/R

PICK A PROBLEM

chances are it's C/R solved

The tiny oil seal that seals in lubrication as it seals out the minute paper fragments which would otherwise break down the delicate mechanism of a complicated business machine, and the huge 48" oil retainer in a four-high steel mill have a common beginning. They both started out as severe operational problems. Also, they are both typical products which resulted from co-operative engineering between the manufacturer and Chicago Rawhide's oil seal engineering specialists.

Such cooperation is an everyday C/R occurrence. In almost every field of manufacture, Chicago Rawhide sealing engineers have worked with the manufacturers' own organizations to smooth out lubrication and sealing problems. That is why, today, you'll find C/R "Perfect" oil seals specified as standard equipment in so many leading products.

For 30 years, C/R engineers have pioneered to find the "Perfect" answer to fluid retention and mechanism protection problems. In addition to the many specially developed seals, for problem applications, C/R seals are available in 15 standard types and 1800 sizes.

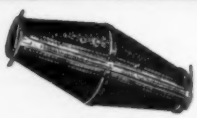
When you specify C/R oil seals for your application, you know you are getting the world's finest sealing device.

Chicago Rawhide engineering service is always available for the solution of your particular sealing problems.

ENGINEERS: We will be pleased to send you engineering data on "Perfect" Oil Seals on receipt of your written request.

CHICAGO RAWHIDE MANUFACTURING CO.

1299 Elston Avenue OIL SEAL DIVISION Chicago 22, Illinois



sirvis

Mechanical Leather Products

Boots, diaphragms, packings and other products give dependable service under difficult operating conditions.

SIRVENE

The Scientific Compounded Elastomer

Custom-engineered and custom-built for critical service in aircraft, automotive and other mechanisms.

C/R PERFECT Oil Seals

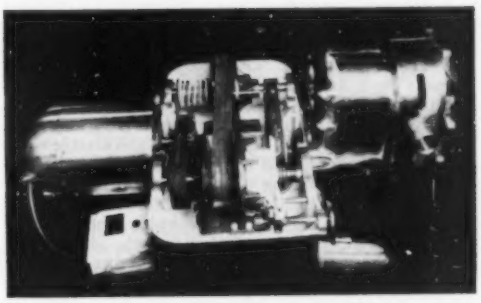
Pump Speed Can Be Varied to Fit Capacity

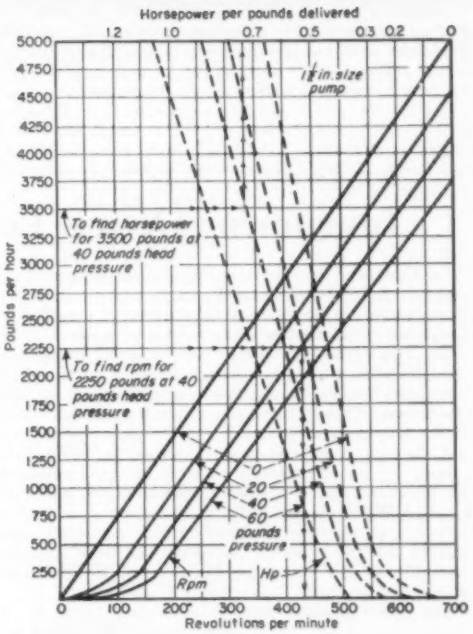
Accurate adjustability within its speed range can be provided, it is said, by a streamlined, corrosion resistant pump whose speed can be varied while running to compensate for changes in capacities. Heavy viscous materials as well as light, non viscous liquids can be pumped. In particular, it is useful with high temperature, short time pasturizers because of the sanitary qualities provided by the corrosion resistant housing that entirely encloses the pump. Adjustable legs give clearance below the base for drainage and, in addition, make possible quick line up with other equipment.

The variable section on which are mounted the pump unit and the motor is of the sheave type, speed adjustment being made by means of a handwheel. The belt is accessible for change. On top of this section is a calibrated dial showing the operating speed of the pump.

The pump unit is a positive displacement type employing balanced twin blade impellers. Featured is an O-ring rotary seal of simple construction that is used in place of more complicated assemblies. Tests have indicated, it is said, that vacuum up to 20 in. of mercury can be maintained without air leakage and that, conversely high line pressures can be sustained without loss of fluid.

Waukesha Foundry Co., Waukesha, Wis.





Pump Capacities Pounds Per Hour Against 20 Lbs Head Pressure		Number and Size of Pump	Pump Speeds Required Against 20 Lb Head Pressure		Motor Required†	
Min	Max		Low	High	Hp	Rpm
250	4200	1½ in	100	650	¾	1800
1200	12000	1½ in	50	480	1	1800
3000	15000	2 in	50	215	1	1800
3000	22500	2 in	50	310	1½	1800
3000	30000	2 in	50	420	2	1800
3000	12500	2 in	50	143	1	1800
3000	20000	2 in	50	218	1½	1800
3000	27500	2 in	50	290	2	1800
3000	40000	2 in	50	412	3	1800
4000	13000	2½ in	45	120	1	1800
4000	20000	2½ in	45	178	1½	1800
4000	30000	2½ in	45	255	2	1800
4000	50000	2½ in	45	412	3	1800
4000	60000	2½ in	45	490	5	1800

Circle No. 7 on Reader Service Card

BAKING ENAMEL with high heat and chemical resistance adheres to nearly all metals and can be either sprayed or dipped. All colors with full gloss, semi-gloss or flat finishes are offered. United Lacquer Mfg. Corp., 1001 W. Elizabeth Ave., Linden, N. J.

DISKS for time cycle control instruments are made of plastic. Unlike the aluminum type they will not crimp during handling, and the timing track can be perforated without leaving a burr. Alleghany Plastics Inc., 785 Chestnut Rd., Sewickley, Pa.

METALLIC BRONZE LACQUERS simulate the appearance of plated metals. Fifteen shades are available; all colors are light-fast, non-fading and lustrous. No dyes or bronze powders are used. National Lacquer and Paint Co., Inc., 7415-39 S. Green St., Chicago 21, Ill.

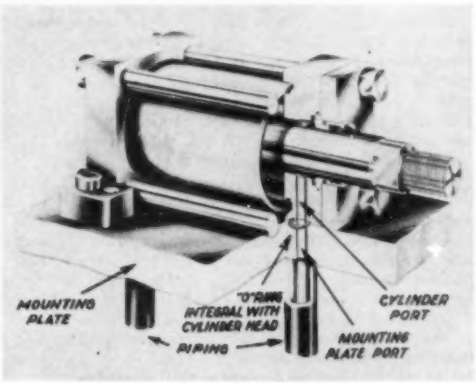
LABELS that can withstand wide changes in temperature and humidity are available for marking fluid lines. E-Z Code Div., Western Lithograph Co., 600 E. 2nd St., Los Angeles.

CONTINUED ON PAGE 222

Cylinders Installed Without Pipe Connections

Actual pipe connections to air and hydraulic cylinders can be avoided with the use of an O-ring cylinder mounting that permits either single or double-unit, side by side manifold mounting. The piping is directly connected to ports in a machined flat surface mounting plate or manifold, and the cylinder is mounted on this plate with its ports mating with the mounting plate ports. The connections are sealed by O-rings that are preassembled into the ports of the cylinder at the mating surfaces to do away with the job of installing the O-rings separately. Installation or removal of the bolts or screws securing the flanges of the cylinder to the mounting plate is all that is required to install, remove, or replace the cylinder.

Other advantages claimed for this O-ring mounting are: increase in hydraulic fluid flow because the O-ring ports are equivalent to ports one size larger than the conventional ports in which the pipe inner diameter fills part of the port hole; minimum pressure loss; smooth fluid flow; avoidance of turbulence and aeration since there are no sudden changes in transverse internal areas of pipes and accompanying fittings that may be necessary.



Miller Motor Co., 4027 N. Kedzie Ave., Chicago, Ill.

Circle No. 8 on Reader Service Card

Instrument Detects Leaks in Vacuum Systems

For those who have occasional need of an instrument to detect a suspected leak in vacuum system, there is such a unit available. It can establish the presence of a small leak in vacuum systems as low as one micron of mercury.

To accomplish its purpose, the instrument makes use of the tendency of hot platinum to emit positive ions when stimulated by infinitesimal traces of halogens or their compounds. Thus to detect a leak, the glass sensitive tube of the leak detector is sealed into the system under test and the system is then pumped down to a moderate vacuum. A jet of Freon gas or other halogen containing gas is directed against portions of the system suspected of leaking. When the jet strikes a leak there is a sudden deflection of the meter needle on the instrument face because the gas, entering the system, instantly increases the ability of a hot platinum anode in the sensitive tube to emit positive ions.

The circuit employs three standard radio tubes and is housed in a cabinet 10¼ in. wide, 7½ in. high, and 8 in. deep. This cabinet comes on a dolly for convenience in working around large systems. The sensitive tube is 5 in. long, $1\frac{5}{16}$ in. in diameter, and has a 3 in. tabulation, $\frac{7}{16}$ in. outside diameter. This may be connected to a system under test with a fitting of the stuffing box type.

Eastman Kodak Co., Rochester, N. Y.

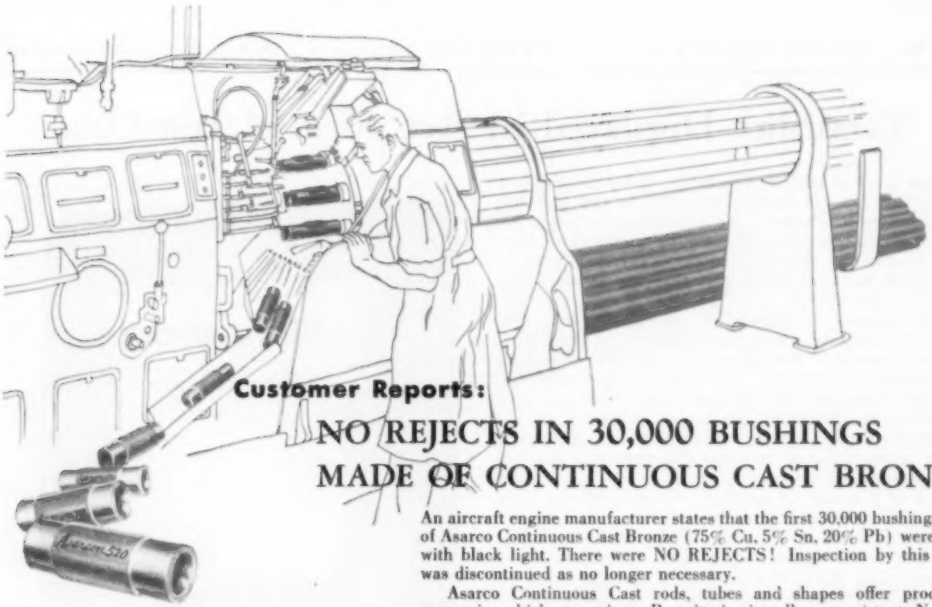
Circle No. 9 on Reader Service Card

FILTERS designed for use wherever dirty liquids are circulated. Simple construction features a radial fin insert made of stainless steel wire. Other materials are available, however. Dollinger Corp., 11 Centre Pl., Rochester 3, N. Y.

ELECTRIC VIBRATORS of the semi-noise-less type substitute rubber striking parts for metallic ones. Proper capacity is insured by a choice of four models that may be used singly or in combination of two or more. Sintron Co., Homer City, Pa.

HEAVY DUTY CASTERS, swivel and rigid, are now made in 5, 6, 8 and 10 in. wheel diameters. Pressure lubricated wheels with roller bearings are available in steel, rubber tread or Celeron. Bond Foundry & Machine Co., Manheim, Pa.

CONTINUED ON PAGE 224



Customer Reports:

NO REJECTS IN 30,000 BUSHINGS MADE OF CONTINUOUS CAST BRONZE!

An aircraft engine manufacturer states that the first 30,000 bushings made of Asarco Continuous Cast Bronze (75% Cu, 5% Sn, 20% Pb) were tested with black light. There were NO REJECTS! Inspection by this means was discontinued as no longer necessary.

Asarco Continuous Cast rods, tubes and shapes offer production economies which are unique. Porosity is virtually non-existent. No sand, dirt or other foreign matter is used in the casting process, so that there are no inclusions to harm tools. Cutting speeds can be high, too. All stock for machining is held to close tolerances and is Medart straightened. Tube concentricities are within 1.5% of wall thickness. Continuous Cast Bronzes are ideal for use on automatic screw machines.

You can get Continuous Cast Bronzes made to order in a wide variety of alloys . . . in standard lengths of 12′ . . . lengths 5′ to 12′ on request . . . lengths 12′ to 20′ on special arrangement.

216 sizes of the standard Asarcon 773 bronze (SAE 660) are stocked in 105″ lengths for convenience at warehouses in principal cities across the country. Distributors will cut the warehouse stock *long or short* to suit your specific requirements.

Send for a free catalog on Asarco Continuous Cast Bronzes. It contains physical properties, photomicrographs, table of stock shapes and sizes, weights and other valuable information.

75% Cu
5% Sn
20% Pb

POROSITY VIRTUALLY ELIMINATED WITH CONTINUOUS CAST BRONZES

Note in these photomicrographs the superior dispersion of constituents in the continuous cast alloy . . . also its outstanding freedom from metal faults.

COMPARISON OF TYPICAL TENSILE STRENGTHS

85-5-5-5 ALLOY

Sand Cast	36,400 psi
Permanent Mold	41,200 psi
CONTINUOUS CAST	45,000 psi

83-7-7-3 ALLOY

Sand Cast	40,400 psi
Permanent Mold	41,600 psi
CONTINUOUS CAST	44,000 psi

In addition to the tensile strength superiority shown above, Asarco Continuous Cast Bronzes have up to 100% higher fatigue characteristics . . . impact strengths increased from 15% to double those of the same alloys cast by other means . . . substantially improved yield strengths, elongation values and hardnesses.

ASARCO
CONTINUOUS-CAST
RODS · TUBES · SHAPES
®

West Coast Sales Agent:
KINGWELL BROS. LTD., 444 Natoma Street, San Francisco, Calif.

American Smelting and Refining Company

OFFICES: Perth Amboy Plant, Barber, New Jersey
Whiting, Indiana

Versatility Displayed by Recorders of Test Data

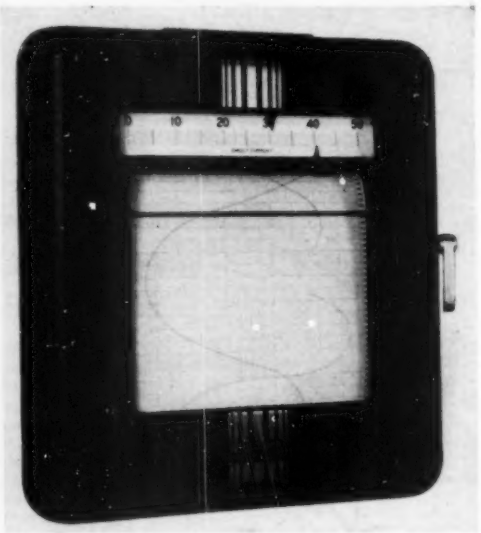
Time spent in tedious compilation and point by point plotting of data can be saved by using the two pen electronic instrument shown in the accompanying photograph. It records two functions simultaneously against time. Since both functions are drawn as continuous curves on a 9¾ in. wide chart, users can follow swift-cnanging variables with ease, it is pointed out.

Two separate electronically-simplified measuring circuits, two balancing motors, and two recording pens are all housed in one case. Circuits can be supplied to work with thermocouples, thermohms, strain gages, tachometers, thermal converters, pH cells, or most other types of primary elements. The instrument can operate controls or alarms.

Recording pens operate overlapping or side-by-side, either across full scale or a specified portion of the full width. Speed of response for full scale pen movement is 3, 2 or 1 second, as specified. Chart speed, the Y or time axis, can be selected in the range of 1 to 1,800 in. per hour. To aid in identification, the instrument draws one curve in red ink, the other in black. Index pointers are red and black to correspond. Any single range may be selected. The same range can apply to both pens, or the ranges may be different.

Another recorder being introduced by the manufacturer has an adjustable zero suppression feature by means of which the operator can ignore that portion of the range in which he is not interested while he spreads the few millivolts he wants to watch across the entire width of the instrument chart. Another feature, adjustable range, permits him to select his own scale calibration at will.

Some typical measurements include: measurements with strain gages for experimental stress analysis, weighing operations and similar matters whereby adjustable zero compensates for tare weight and range can be adjusted to provide the desired scale calibration; temperature difference measurements with thermocouples to measure small temperature changes at elevated temperatures; speed measurements in which by using an electric tachometer as the primary element, this recorder can measure change of speed over a narrow range, or assist in the study of speed regulation characteristics of motors, engine governors, and other mechanisms.



Calibrated d-c millivoltage range is adjustable from a minimum across-chart span of 1.1 mv to a maximum range span of 22 mv. Uncalibrated coarse and fine rheostats provide maximum zero suppression of —50 or +50 mv, continuously adjustable between these limits. These adjustments are independent. Range remains constant during zero adjustment; zero suppression remains constant during range adjustment.

Leeds & Northrup, 4934 Stenton Ave., Philadelphia, Pa.

Circle No. 10 on Reader Service Card

Process Smooths and Brightens Aluminum

Two years of research have resulted in an aluminum finishing process that is said to give a bright surface as well as a smooth clean surface for electroplating. Moreover, handling is reduced and the results are uniform. The process consists of a cleaning operation followed by immersion of the part in a chemical bath for which the equipment and procedures are similar to etching. The last step is an acid dip—omitted for anodized parts.

The chemical bath uses a dilute solution of common chemicals. This makes for low dragout loss and ease in handling. The dilute solution is not excessively active, nor does it evolve large amounts of gas during processing. This allows relaxed control in processing and uniform results on the finished part. The slight amount of fume evolved from the tank is mainly steam. No serious health or corrosion hazard is present. While the dilute solution is acid and should be treated with proper precautions, there is no serious danger from skin contact.

This brightening process can be used with all wrought aluminum alloys, but is particularly effective with high purity aluminum and alloys 2S, 3S, 52S, 61S and 150S.

Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago, Ill.

Circle No. 11 on Reader Service Card

CONTINUED ON PAGE 226

Introducing "Formbrite"

Specially processed copper alloys with a money-saving grain structure

Formbrite is a metallurgical development of The American Brass Company applied to copper alloys, particularly brass. A special rolling or drawing process plus a special heat treatment impart a superfine grain structure to the metal.

Because of its fine grain and hard surface, substantial economies can be effected in polishing and finishing. Usually only a simple color buff is required before plating.

As a drawing brass in the form of sheet or strip, Formbrite is stronger, harder and more resistant to scratching and abrasion—yet so ductile that it readily withstands deep-drawing operations.

In the form of rod and wire, Formbrite has about the same strength as regular cold heading wire—with good ductility. It is ideal for rivets, wood and machine screws and upset products generally. A minimum tumble cleans and polishes Formbrite fastenings.

Formbrite is beyond the experimental stage. Millions of pounds have been made, sold and satisfactorily fabricated and finished. It costs no more than standard drawing or cold heading brass. If you are cold-working brass in the form of sheet, strip or wire, you will want to know more about Formbrite. Write for Publication B-39 . . . and if you'd like to compare Formbrite with ordinary drawing brass in your own polishing room, ask for the kit of two sample cups. The American Brass Company, General Offices, Waterbury 20, Conn.

Formbrite is a trademark of The American Brass Company designating copper-base alloys of exceptionally fine grain, combining unusual polishing characteristics with good strength and hardness, plus excellent ductility.

ANACONDA

the name to remember in

COPPER · BRASS · BRONZE

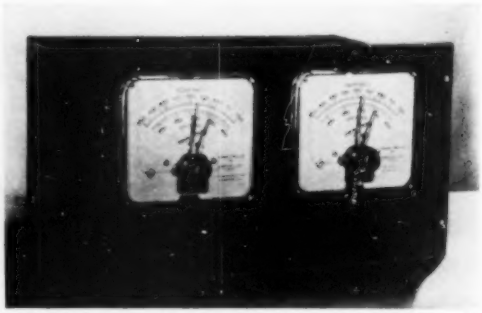
Instrument Controls Temperature of Dimpling Dies

This automatic pyrometer control has been designed for controlling the temperature of dimpling dies used on aircraft structures. The unit includes two double contact meter relays, one for each section of the die. Each meter has an on and off contact for regulating the heat of the die and a low limit contact for safety shut off.

Temperature range is from 350 to 750 F. Other ranges can be supplied for temperatures from minus 75 to 3,000 F. The corresponding Centigrade markings are shown on all dials. Meter contact settings are adjustable over the full temperature range.

No vacuum tubes are used in these controls. Control action is by direct contact in the locking contact meter relays. Current in the contact circuit is carried through an extra winding on the meter moving element. Contacts are separated by an automatic interrupter relay.

Controls are made in single or multiple units.



Assembly Products, Inc., Chagrin Falls, Ohio

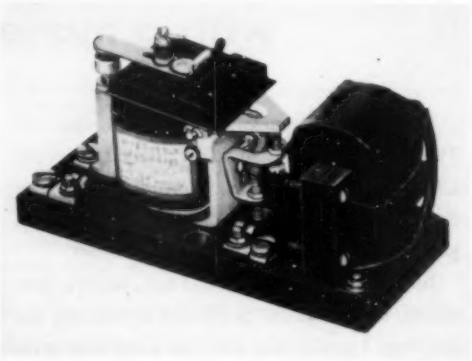
Circle No. 12 on Reader Service Card

Relay Provides Close Voltage Differential

To a line of magnetic relays for industrial and commercial control applications has been added another that is intended for use in a-c circuits where a close voltage differential between relay pickup and dropout is needed. A typical application is protecting a-c motors up to 2 hp against damage caused by low line voltages. Others include power and lighting bus transfer and, in some cases, over-voltage protection.

These relays consist essentially of an insulating base on which are mounted a power type 130 a-c magnetic relay, with single pole, normally open contacts and a small saturable reactor. The relay coil and reactor are connected in series. Because the reactor imparts non linear characteristics to the relay circuit, slight voltage changes across the series combination result in wide current variations required for close differential operation.

Nominal coil voltages for heavy duty types are 115, 230 and 440 v 60 cycles, for light duty types 115 and 230 v 60 cycles. Heavy duty contacts are rated at 25 amp, 230 v, 60 cycles, 2 hp maximum.



Ward Leonard Electric Co., 31 South St., Mount Vernon, N. Y.

Circle No. 13 on Reader Service Card

Valve Unloads Without Back Pressure to Tank

The purpose of this valve is to unload one part of an oil hydraulic circuit at no back pressure to the tank. It is operated by pilot pressure from some other part of the circuit. Free flow to the tank continues as long as the pilot pressure is higher than the setting of the valve.

The valve features a balance piston design for close accurate fit in the valve bore. It is available in sizes ¼ to 1½ in., in two pressure ranges of 50 to 150 psi and 500 to 1,500 psi, adjustable from minimum to maximum in both ranges.

The model number of this valve is 8826. It is a new type unit that has been added to the standard line by the manufacturer. Complete details on operation and construction can be obtained on request.

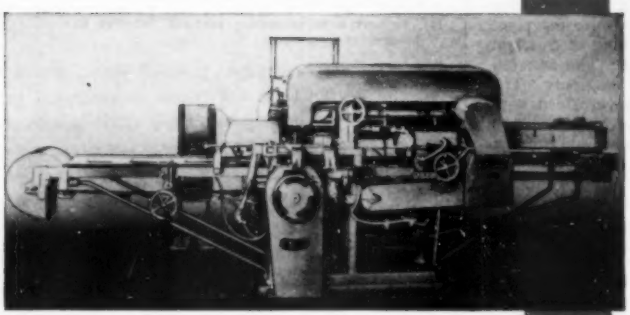
Rivett Lathe & Grinder, Inc., Brighton, Boston, Mass.

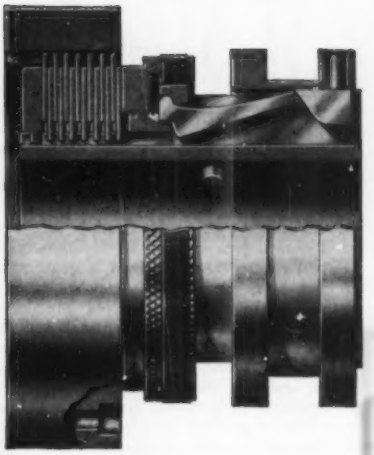
Circle No. 14 on Reader Service Card

CONTINUED ON PAGE 228

MAXITORQ

Keeps Good Company





. . . in the PACKAGING FIELD

The MAXITORQ floating disc CLUTCH takes care of power transmission in this Model FF packaging machine, used in freezer plants to overwrap frozen food packages.

The Package Machinery Company, Springfield, Mass., one of the largest manufacturers of packaging machinery in the world, builds approximately 100 different models of machines. Their engineers say, "We have been so well satisfied with the Maxitorq Clutch that we have adopted it as standard on practically all machines we build that require a clutch type of drive."

This specific Maxitorq is the NO. 23, single dry type, 1 H.P. at 100 r.p.m., 4-1/32" long, 3-15/16" dia. There are 8 standard capacities, ¼ to 15 H.P. single or double, wet or dry. Separator springs keep discs "floating" in neutral . . . prevent drag, abrasion, heating. Assembly, adjustment, take-apart are manual . . . no tools required. Disengagement is instant and complete.

Within its capacity, the Maxitorq Clutch serves many applications for machine tools, industrial products, mowers, textile, printing, mining, lumbering, packaging and a host of other machines. Ask for our engineering recommendations . . . join "Maxitorq's good companies."

Send for Catalog No. PE5

1C-J51

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

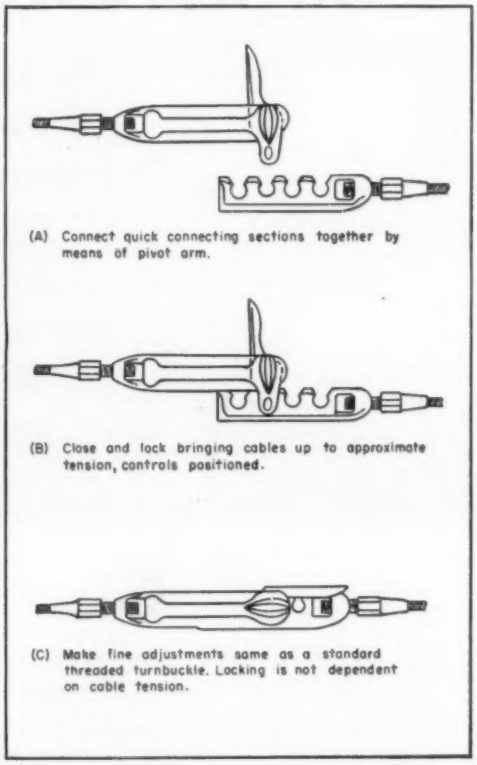
Turnbuckle Speeds Aircraft Cable Rigging

Rigging the cable operated control systems of aircraft presents a number of problems. One is the difficulty in maintaining definite cable lengths throughout a given number of units. Second, considerable time is lost in connecting various sections together with turnbuckles and in the final rigging of the ship. Third, the same time consuming rigging job must be done each time the cable system is broken down for repair, service or shipping.

To solve these problems, a quick connecting turnbuckle has been produced. It consists of three main parts, a frame and a link connected and locked by a pivoting lever or arm. The frame is notched to receive the pivot end of the arm, and the closing and locking of this arm into the frame increases the cable tension. The arm can be inserted into anyone of the slots in the frame. The opposite ends of the frame and link are provided with threaded portions to allow the closed and locked unit to be used like other turnbuckles for fine close adjustments. Openings are provided to assure proper thread bearing.

The difficulties encountered in maintaining uniform cable lengths, problem one, are overcome by this new turnbuckle because its take-up is so much greater than that of the conventional type. Thus, for the $\frac{5}{32}$ in. cable model, the take-up in the threaded portion is 0.687 in. plus 0.875 in. in the quick connecting portion. The conventional turnbuckle has a total of 0.42 in. in takeup. Problem two is the loss of time in rigging cable systems. Time required with the new turnbuckle can be reduced by connecting all the turnbuckles at their extreme length except one that is accessible. From the position of this one, the amount of take-up needed is determined, the necessary adjustments to the others are made, and then the tension on the entire system is built up using the readily accessible one. Problem three is time lost each time the cable system is broken down. This time is cut when the new turnbuckle is used.

R & D Turnbuckles, 698 Englewood Ave., Kenmore, N. Y.



(A) Connect quick connecting sections together by means of pivot arm.

(B) Close and lock bringing cables up to approximate tension, controls positioned.

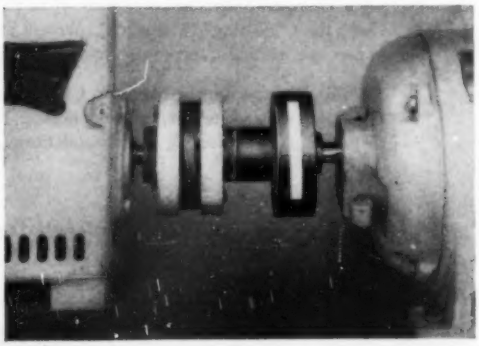
(C) Make fine adjustments same as a standard threaded turnbuckle. Locking is not dependent on cable tension.

Circle No. 15 on Reader Service Card

Mercury Clutch Provides Mount for Flexible Coupling

Recently announced was a mercury clutch coupling, a complete unit consisting of a mercury clutch with provision for mounting a flexible coupling between it and the driven load. The mercury clutch coupling used in conjunction with a flexible coupling provides a satisfactory connection, it is claimed, between the motor shaft and the driven shaft without the necessity of maintaining exact alignment. The unit has been designed for installation on the shafts of integral horsepower electric motors up to 15 hp in rating.

Automatic Steel Products, Inc., Canton, Ohio



Circle No. 16 on Reader Service Card

CONTINUED ON PAGE 229

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. . the latest catalogs and manufacturers' bulletins?

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KEEP UP TO DATE

Every month Product Engineering describes in detail the most significant NEW developments in parts, materials, components, and products . . . and lists scores of NEW catalogs and bulletins available from manufacturers. To obtain additional information on these new products and to get copies of any manufacturer's bulletin of interest to you, use the postcards on these pages.

USE THIS CARD

- For further information on products described in the New Components, Materials, and Parts Department, circle the postcard number.
- For additional information on products advertised in this issue, fill in numbers of the pages on which the products are advertised in spaces provided on postcards. Use advertiser's initial if more than one advertisement appears on a page. Write in name if pages are unnumbered.
- For copies of any manufacturers' bulletins described on page 256, and following, circle postcard number.

PRODUCT ENGINEERING: *Not good after 7/1/51*

Please send me more information on the New Parts and copies of the New Bulletins identified by numbers circled below:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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Readers' Service Department

PRODUCT ENGINEERING

330 West 42nd Street

New York 18, N. Y.

READER SERVICE

KEEP UP TO DATE

NEW CATALOGS AND BULLETINS

NEW PARTS, MATERIALS, AND COMPONENTS

PRODUCTS APPEARING IN THE ADVERTISING PAGES

Getting ALL the information about ALL of the significant new developments in the design field every month is a tough . . . and time consuming . . . job. To save you time, the editors of Product Engineering screen hundreds of new products each month, select the outstanding ones, and check the manufacturer of each for additional information on construction, operation, and applications prior to describing them on the editorial pages. They scan scores of new catalogs and bulletins, present summaries only of the ones they know will be of interest.

The result is time saved . . . for you. All you have to do to get further information is to fill in the easy to use postcards on these pages. Product Engineering's Reader Service Department will do the rest. Note: Please reserve one of these cards for the engineer who gets the issue after you. He too is interested in new developments.

For new Catalog and Bulletins descriptions turn to Page 256.

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Advertising on pages					

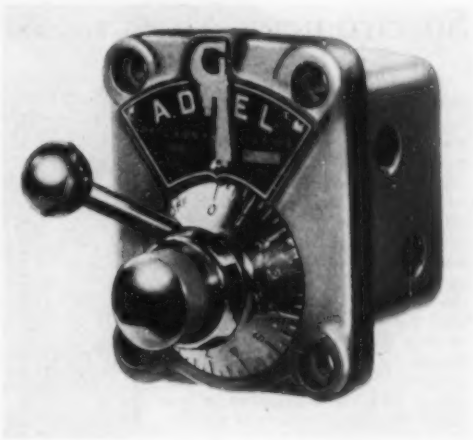
NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ STATE_____ 5/51

Valve Holds Flow Stable Over Wide Pressure Range



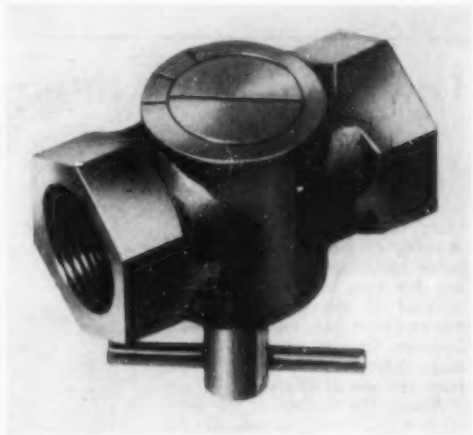
Hydraulic circuits and systems can be provided with a compensated type flow control valve that maintains constant fluid flow over a wide range of pressures or constant machine feed over a wide range of feed resistances. The valve is adjustable from completely shut off position to 25 gpm maximum flow. Its maximum recommended inlet pressure is 1,500 psi; the maximum outlet pressure is equivalent to 100 psi less than the inlet pressure. No drain line is required. The long arc of control lever rotation, 270 deg, makes for accurate flow settings.

The valves comes in 8 models, four in the $\frac{1}{4}$ in. pipe size and four in the $\frac{3}{4}$ in. pipe size. Those in the $\frac{3}{8}$ in. pipe size supply 1, 2, 4 or 6 gpm maximum flow. Those in the $\frac{3}{4}$ in. pipe size supply 10, 15, 20, or 25 gpm maximum flow.

Adel Div. of General Metals Corp., 10777 Van Owen St., Burbank, Calif.

Circle No. 17 on Reader Service Card

Valve Uses O-Ring Seal To Overcome Leakage



A stop cock for regulating the flow of water or other liquids is fitted with an O-ring seal that is said to do away with external leaking. Moreover, the plug is fitted closely to reduce internal weeping. The fit, though, is such that it turns easily. One quarter turn opens or closes this all brass valve, and it can be assembled or disassembled quickly.

This type of valve is used on jet pumps, spray pumps, boiler feed lines and similar places. In size it is $2\frac{1}{2}$ in. long and fits a $\frac{3}{4}$ in. pipe. There is a choice of two plugs. One is full ported with an area of a one in. pipe in port. The other is a $\frac{1}{4}$ in. port that may be used in place of needle valves or for similar fine adjustments. Detailed information can be secured from the manufacturer.

Reynolds Shaffer Co., 12100 Cloverdale Ave., Detroit, Mich.

Circle No. 18 on Reader Service Card

Molded Plastic Fittings for Plastic Piping

Injection molded plastic reducing bushings and end plugs for use with the manufacturer's plastic pipe are now available. Their design incorporates a hexagonal ring for positive wrench grip and International Pipe Threads. The reducing bushings come in 15 sizes ranging from 2 x $1\frac{1}{2}$ in. down to $\frac{3}{4}$ x $\frac{1}{2}$ in., and the end plugs are obtainable in 6 sizes from 2 to $\frac{1}{2}$ in. The range of sizes make only one reducer bushing necessary to reduce one size pipe to another.

Molded from a single piece of thermoplastic material, they are light weight, can be installed rapidly, and assure leak-proof connections. Also, they are resistant to many chemicals.

Carlon Products Corp., 10225 Meech Ave., Cleveland, Ohio

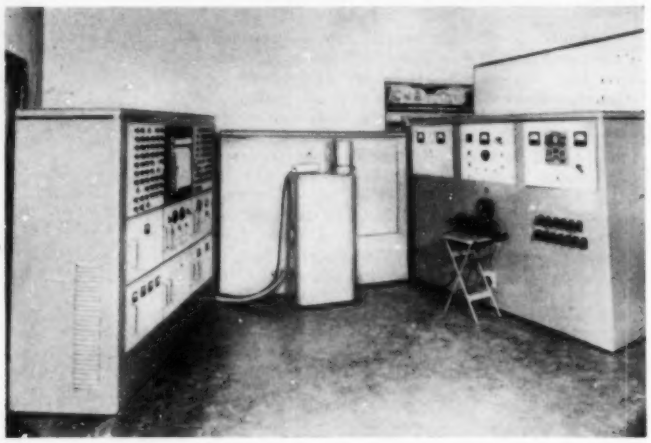
Circle No. 19 on Reader Service Card

CONTINUED ON PAGE 240

Spectrometer Measures Alloy Constituents Rapidly

Almost instantaneous analysis of metals can be made by a direct reading spectrometer that is said to represent the most advanced unit of its type. It is applicable to a wide variety of metals including stainless steel and similar materials but there are believed to be additional uses in many other inorganic fields. A single instrument can measure 25 elements, up to 20 simultaneously. In addition, the instrument can be designed to meet the requirements of a number of large plant problems as it is not limited to one type of analysis. Its accuracy is such that results comparable to chemical analysis can be produced. Recorded analyses of samples, element by element, can be provided within a period of two minutes.

Applied Research Lab., Glendale, Calif.



Circle No. 20 on Reader Service Card

Low Speed Motor Incorporates Brake

A recently introduced electric power drive development is a geared head, fan cooled motor that incorporates a motor-mounted disk-type brake. The brake can be supplied for either stopping or holding service. Both motor and brake are totally enclosed and dust tight so that the drive can be used in atmospheres containing non-explosive dust, vapors and other injurious foreign materials. Ratings range from 2 to 15 hp and speeds from 280 rpm to 30 rpm inclusive.

Among the features of this product is a dual cooling system that provides an internal fan to circulate air inside the motor and an outer fan to pass cooling air over the case.

Sterling Electric Motors, Inc., Los Angeles, Calif.

Circle No. 21 on Reader Service Card

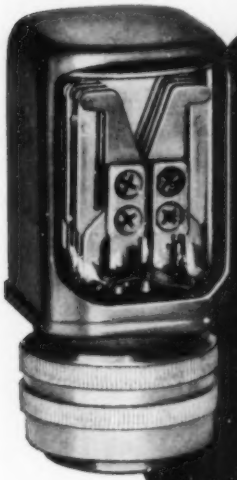
BRAZED JOINTS made with a copper brazing paste containing iron are said to be stronger than those employing more copper. Paste also reduces fluidity of the brazing material. Glidden Co., Cleveland, Ohio.

VARIABLE SPEED DRIVE, approximately 4 in. overall length, rated up to 2 lb-in of torque, 0.025 hp and 20,000 rpm, now has a direct, level type speed control. Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.

CASTER with 10 in. pneumatic wheels moves loads up to 1,200 lb with minimum shock and vibration. Sparkproof. Cased bearings reduce race wear. Aerol Co., Inc., 2820 Ontario St., Burbank, Calif.

CONTINUED ON PAGE 232

AN approved (3303-1)



R-B-M

ELECTRONIC AND COMMUNICATION RELAYS

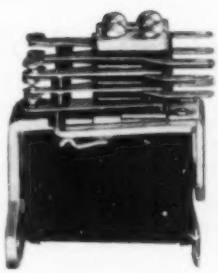
Now Hermetically Sealed

AN approved (3304-1)

● Hundreds of thousands of R-B-M telephone type relays saw Government service in World War II. Now most of these relays are available in hermetically sealed enclosures designed to meet AN specifications.

R-B-M hermetically sealed telephone type relays are available in contact forms up to and including 4-pole, double throw, 3 ampere, 28 Volts D.C. construction. Also 10 ampere rating up to and including 2-pole double throw at 28 Volts D.C. All relays available with approved AN plug connector, or solder connections.

Engineers! What is YOUR hermetically sealed relay requirement? R-B-M is developing new and smaller relays to meet Armed Services requirements. Perhaps one of these will solve your problems. Write giving complete relay specifications, application, quantity and AN specifications applying. Address Dept. C-5.



R-B-M Production and Engineering facilities in two plants, located in different states, (over a quarter million square feet), can assist you in the development and production of special electro-magnetic devices for Armed Services application.

RBM

R-B-M DIVISION ESSEX WIRE CORP.

Logansport, Indiana

MANUAL AND MAGNETIC ELECTRIC CONTROLS — FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE

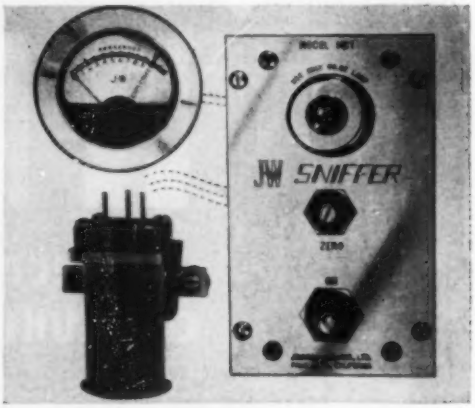
Combustible Gas Indicator Fits Limited Space

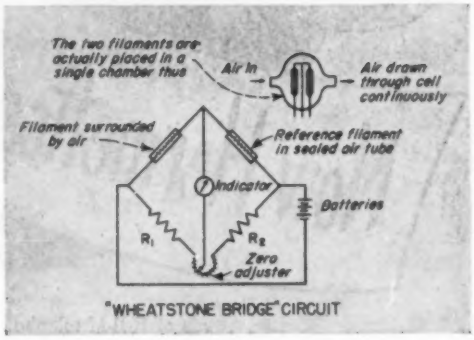
Engineered along building block lines to permit separate mounting of controls and indicating meters in marine installations where space is at a premium, this combustible gas indicator reveals the presence of combustible vapors so that measures can be taken to prevent the concentration becoming dangerous. It is made up of three units, indicating meter, control box and detector head, interconnected with heavy cables. All are constructed of corrosion resistant materials finished in chrome.

The meter, a 2¾ in. hermetically sealed, flush mounting type, which can be placed anywhere on the instrument panel, shows the concentration of combustible gas. The control box, which can be placed at a convenient remote location, carries a toggle switch that puts the instrument into operation and a pilot light to show that the instrument is in service. The pilot light also checks on the operation of the detector unit and monitors the voltage regulation. The detector head, protected with five thicknesses of heavy close mesh monel metal screen, mounts low in the hull where explosive vapors collect.

Operation is based on the fact that when a mixture of air and combustible gas or vapor is brought in contact with a hot platinum wire, rapid combination of the combustible with the oxygen of the air takes place at the surface of the wire, raising the temperature of the wire, and consequently increasing its electrical resistance. This change in resistance actuates the meter. Consequently, the amount of combustible present is indicated directly by the meter.

Johnson William, Ltd., 2632 Third St., Palo Alto, Calif.





"WHEATSTONE BRIDGE" CIRCUIT

Circle No. 22 on Reader Service Card

D-c Reference Voltage Stable to 0.25 Percent

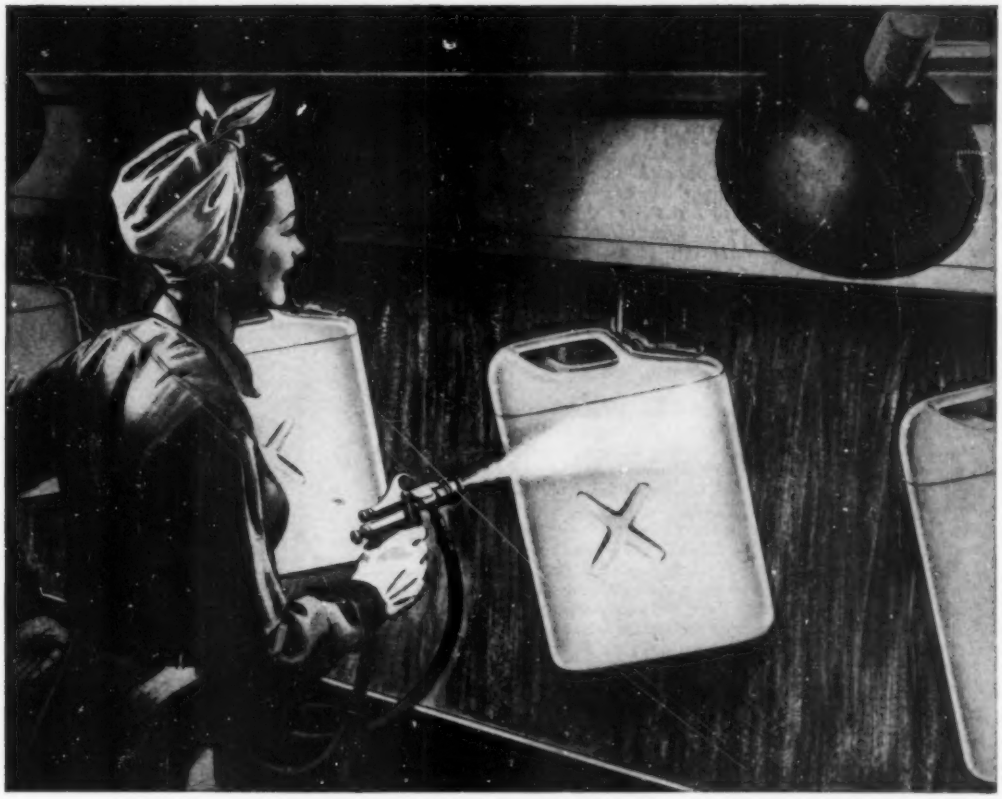
Self balancing potentiometers, wire strain gages, recording oscillographs, resistance thermometers and similar instruments used both in industry and laboratory can be provided with an electronic standard cell that gives a d-c reference voltage stable to 0.25 percent. Output ripple on the low current models is said to be less than 0.01 percent. Stability is maintained under wide temperature range operation and under continuous, long term use. Momentary short circuits cause no damage.

Models can be secured with reference voltages of 1.00, 10.00, 100,00 v. or the eletrochemical standard cell voltage of 1.018 v. Units for any voltage from 0 to 100 v with current drains from 0 to 30 ma are also available. All operate from an a-c source; 90 to 130 v, 50 to 500 cycles. The electronic standard cell is housed in a gray instrument case of open grill design.

Hastings Instrument Co., Inc., Hampton, Va.

Circle No. 23 on Reader Service Card

CONTINUED ON PAGE 234



Speed at your production lines means speed to the front lines!

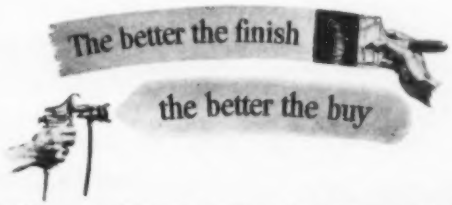
CONSULT YOUR INDUSTRIAL FINISHES SPECIALIST

You're meeting more than consumer demand when you're manufacturing for the armed services. You're meeting demand that might mean life or death, success or failure for our armed forces.

You can't take chances with a finish for fuel tanks, for instance. For World War II, government specifications called for a finish that would resist salt water, sand abrasion, rain, sun and abnormal wear conditions. It was up to Industrial Finishes Specialists to find the answers. Working with government experts, they developed finishes that helped keep fuel moving to the front. Today they are developing special finishes for just about every type of military equipment, and for just about any type of climatic condition that could be encountered.

And war-emergency research such as this inevitably results in finer finishes for the products that are bought for the home.

So if you're manufacturing for defense orders, consult an Industrial Finishes Specialist. He can help you solve production and cost problems, maintain product quality, whether for defense or civilian needs.



© 1951, National Paint, Varnish and Lacquer Association, Inc., Washington 5, D. C.

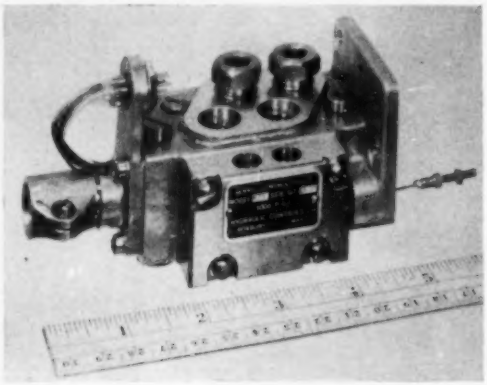
Valve Controls Electro Hydraulic Servomechanisms

The servo control valve is a precision component for use in high performance electro-hydraulic servomechanisms requiring high natural frequencies and delivering in excess of 5 hp. The servo valve consists of two sections, a pilot valve and a power valve. The pilot valve, acting as a preamplifier, controls the position of the power valve, which in turn controls the delivery of up to 5 hp of hydraulic power to a ram or hydraulic motor. The pilot valve requires for its maximum effectiveness an electro-mechanical transducer, such as a torque motor, capable of displacing the pilot piston 0.004 in. and exerting a force output of 4 pounds.

To insure stability and to improve the linearity of the servo system in which it is employed, the position of the power valve is measured electrically by a linear differential transformer pickoff. This pickoff is linear within 1 percent over the range of travel of the power valve. When excited with 10 v at 400 cycles per sec, its sensitivity is 9 v per in. zero output from the pickoff to correspond to the neutral position of the valve is easily obtained.

By providing 0.0002 to 0.0004 in. underlap between the lands of the pistons and their corresponding ports, high performance, low dither level, and continuous linear output down to displacements of 0.0001 in. are obtained. The bores of both the pilot and power valves are lapped to insure negligible leakage past the lands. The internal leakage at 3,000 psi is approximately 0.15 gallons per minute in each valve.

Although the device is suitable for any servo system, its high pressure rating and capacity make it especially adaptable to aircraft and military applications.



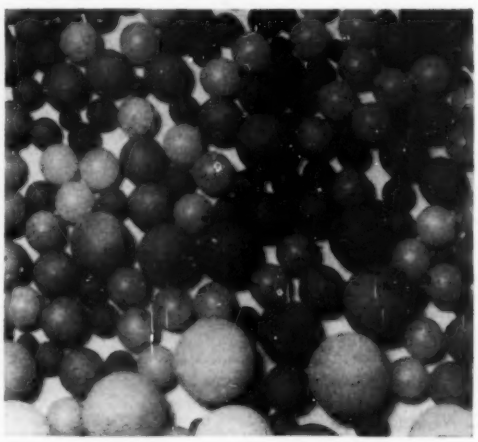
	Model MX	Model XA
Max Power Output (3,000 psi)	5 Hp	2.5 Hp
Max Output Flow Rate (3,000 psi)	8.8 Gpm	4.1 Gpm
Pilot Valve Stroking Force (3,000 psi)	135 lb/in.	75 lb/in.
Hydraulic Tubing Diameter	5/16 in.	1/4 in.
Max Operating Pressure	3,000 psi	3,000 psi

Hydraulic Controls Co., 87 Terrace St., Roxbury 20, Mass.

Circle No. 24 on Reader Service Card

Seamless Nylon Balls Have Close Tolerances

Nylon plastic balls, mass produced to tolerances of ±0.001 in. on diameters and 0.001 in. on sphericity, are now available to manufacturers for use in valves, valve components, specialized friction bearings, dedents, mechanical checks and numerous other commercial and industrial applications. In sizes from $\frac{1}{8}$ to $\frac{3}{4}$ in., these seamless Nylon balls provide toughness at low temperatures, resistant to abrasion, stable in form at high temperature, lightness in weight and chemical resistance. For example, flow temperature of Nylon balls is above 480 F, the coefficient of linear thermal expansion is 5.5×10^{-5} in. per in. per deg F, and 1.7 Btu per hr/sq ft per deg F per in. is the thermal conductivity. Electrical properties include a short-time dielectric strength of 385 v per mil, a dielectric constant of 4.1 at 60 cycles. Among the mechanical properties are a tensile strength at 70 F of 15,700 psi and at 170 F of 7,600 psi, while 9,600 psi is the shear strength. Water absorption is 1.5 percent. Flammability is no problem since Nylon is self extinguishing.



Ace Plastic Co., 91-30 Van Wyck Blvd., Jamaica 1, N. Y.

Circle No. 25 on Reader Service Card

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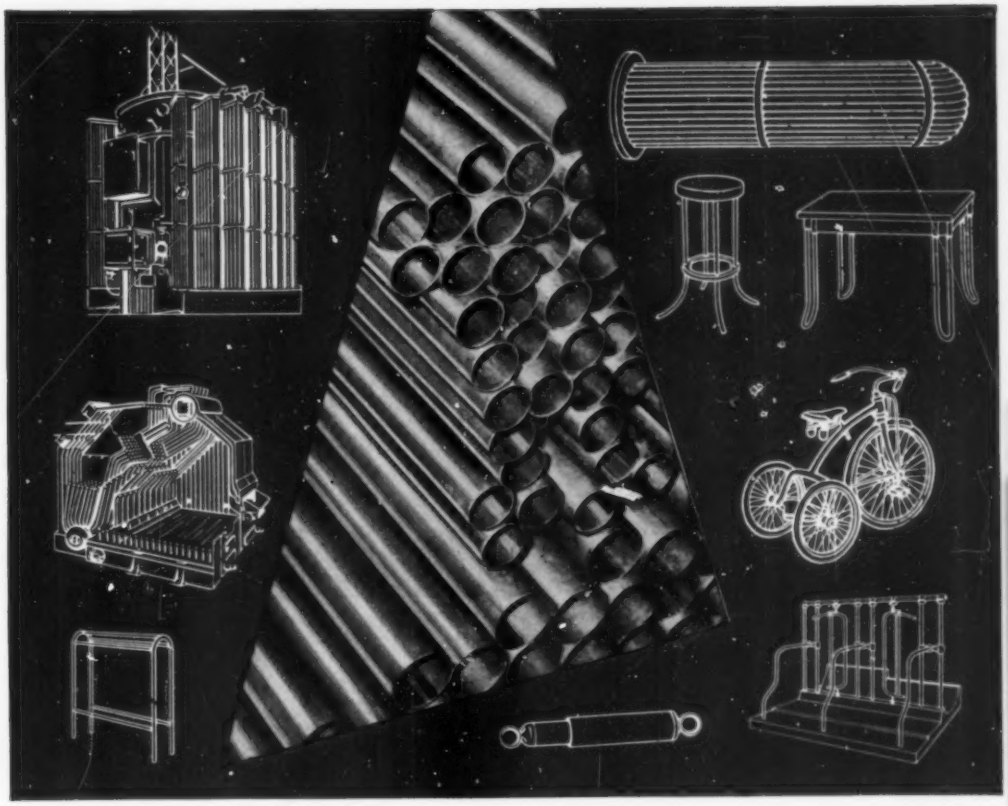


WHY MORE AND MORE TUBING MADE
"The Yoder Way"
GOES INTO THINGS DESIGNED TO STAY

Since Yoder in 1939 first introduced their electric-weld tube mills, high quality tubing at low cost has become available in quantities heretofore undreamed of.

The relatively low first cost of these mills, compactness, simplicity of operation and high production, virtually created a new industry, specializing in making fine tubing and making fine things from tubing.

Thousands of manufacturers of automotive equipment, household appliances, home and business furniture, farm equipment, bicycles, garden tools, boiler tubes, electric conduit, etc., have found in this tubing a ready means of making their products lighter and more attractive in appearance, yet stronger and longer lasting.

As a result, the demand for tubing has increased faster than the supply, so that tube-making "the Yoder way" today, more than ever, offers attractive rewards to private enterprise.

Send for 68-page book of information on the mechanics as well as the economics of tube making. Estimates and recommendations for the asking.

THE YODER COMPANY • 5522 Walworth Avenue, Cleveland 2, Ohio

Complete Production Lines

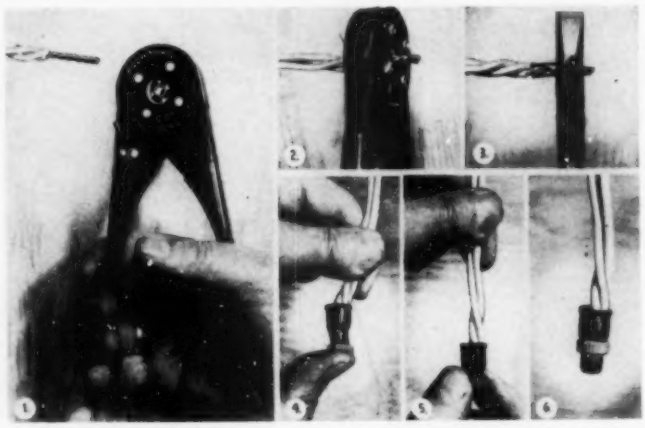
- ★ COLD-ROLL-FORMING and auxiliary machinery
- ★ GANG SLITTING LINES for Coils and Sheets
- ★ PIPE and TUBE MILLS–cold forming and welding

ENGINEERING YODER MANUFACTURING

Improved Splice Cap Facilitates Installation

For "pigtail" splicing of electrical wires, there is a splice cap whose open end construction is said to facilitate its installation and inspection. It is designed to insure that wire insulation is always flush with the splice cap for maximum circuit protection and that wires are always inserted to the full depth of the splice cap for maximum joint efficiency. Only two sizes of splice caps are required for the most frequently used combinations of two or more wires ranging from two No. 18 to three No. 8. Snap-on insulators of fixed insulating value do away with the necessity for taping of joints and prevent insulation breakdown in service. A companion to the splice cap is a lug for both single and multiple wire terminations. Both are installed by special tool.

Buchanan Electrical Products Corp., Hillside, N. J.



(1) INSERT TWISTED WIRES into splice cap, held in pressure tool. (2) Crimp splice cap. (3) Cut off excess wire protruding beyond splice cap. (4) Push on insulator. (5) Turn up locking ring. (6) Insulation is completed.

Circle No. 26 on Reader Service Card

Sky Rule Supplies Aircraft Data At a Glance

Engineers of the Douglas Aircraft Co. have developed a slide rule, called the Sky Rule, for computing aircraft performance data without recourse to voluminous text books and charts. In addition to the conventional C, D and A scales, it has 20 others peculiar to aviation. Scale markings are theoretically accurate to one ten thousandth of an inch, it is said.

With the Sky Rule it is possible to determine at a glance the Mach number, true air speed, indicated air speed, density altitude, temperature rise and numerous other aeronautical functions. Airplane performance may be evaluated either in mph or knots without reference to conversion tables. Two scales permit conversion from degrees Centigrade to corresponding Fahrenheit readings and mph to knots.

Pickett & Eckel, Inc., 5 S. Wabash Ave., Chicago, Ill.

Circle No. 27 on Reader Service Card

PLASTICIZER makes old rubber parts feel and perform like new, it is said. Surfaces hardened cracked and become inelastic can be made serviceable again. Schwartz Chemical Co., Inc., 326-328 W. 70th St., New York 23.

MASKING COMPOUND protects surfaces from welding arc spatter and flame. Spread on with a welding flux, it is easily removed after the welding operation. Eutectic Welding Alloys Corp., 40 Worth St., New York.

STROBOSCOPE, 1½ in. in dia by 5 in. long, operates like a flashlight to indicate synchronous speeds. Its tube rectifies light during the positive portion of the a-c cycle. Synchroscope Co., 57 William St., New York, N. Y.

CONTINUED ON PAGE 238

for **BORON STEELS**

GRAINAL TREATMENT
meets new specifications

To meet the requirements of boron-treated steels, use Grainal Alloys—metallurgically engineered multiple-element ferro-alloys containing boron.

The combination of elements in these alloys is *most effective* and produces *extremely uniform* results in raising the hardenability of very low alloy steels.

Nominal compositions of three grades available:

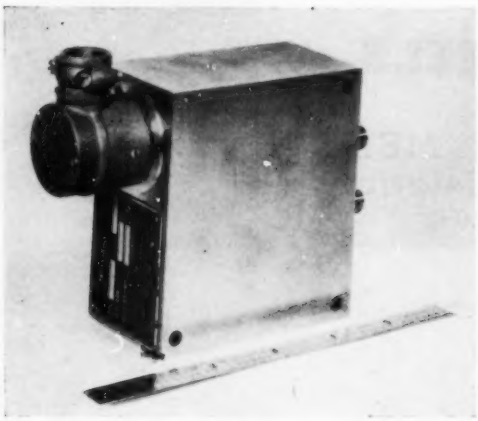
Vanadium Grainal No. 1		Vanadium Grainal No. 6		Grainal No. 79	
Vanadium	25.00%	Vanadium	13.00%	Aluminum	13.00%
Aluminum	10.00%	Aluminum	12.00%	Titanium	20.00%
Titanium	15.00%	Titanium	20.00%	Zirconium	4.00%
Boron	0.20%	Boron	0.20%	Manganese	8.00%
				Boron	0.50%
				Silicon	5.00%

VANADIUM CORPORATION OF AMERICA

420 LEXINGTON AVENUE, NEW YORK 17, N. Y. • DETROIT • CHICAGO • CLEVELAND • PITTSBURGH

MAKERS OF ALLOYS
VANCORAM
CHEMICALS AND METALS

Accuracy Improved in Cells Used With Controllers



THESE DIFFERENTIAL PRESSURE CELLS based on SR-4 resistance wire strain gage measurement are interchangeable, precision products used with indicating, recording and controlling instruments to take differential measurements of fluid and gas pressures. In addition, the cells may be used for measurement of flow, liquid level, and for other purposes such as determination of airfoil pressure distribution in wind tunnel tests.

Each cell consists of a pair of matched Monel metal pressure bellows arranged to apply opposing forces on a cantilever beam to which SR-4 strain gages are bonded. The sensing element is hermetically sealed by solder in an aluminum box. Electrical connections are made through glass-to-metal seals. The cell is insensitive to linear acceleration in any direction and may be mounted in any position without affecting pressure indications.

Differential cells are designed for the standard 120 ohm circuit and for 300 ohm circuits. Recommended input voltages are 6 v and 12 v respectively with maximums of 8 and 16 v respectively. Output at rated differential pressures is 2.000 ± 0.005 millivolts per volt input. Cells are temperature compensated for zero and span. Calibration accuracy is within ¼ percent of full scale anywhere within the rated range. Two pressure ranges are available: ±10 and ±20 lb per sq in. Maximum permissible line pressures are 50 and 100 lb per sq in. respectively.

A SERIES OF SR-4 UNIVERSAL (TENSION-COMPRESSION) LOAD CELLS have been redesigned for larger scale production. They have the same construction as those they replace and contain sealed in sensing elements consisting of SR-4 resistance wire strain gages bonded to a steel column or bar and compensated for temperature variations. However, the safety factor for overloads has been increased and the accuracy with off center loads is said to be better. They may be used with indicating, recording or controlling instruments for industrial weighing and related purposes. Female threads on both ends of the cells take tension or compression fittings.

Rated load capacities are 500, 1,000, 2,000, 5,000, 10,000, 20,000 and 50,000 lb. Repeated overloading to 120 percent of rated capacity causes no adverse effects. Repeated overloads to 150 percent of rated capacity may cause a slight zero shift but will not impair measuring qualities although some shortening of cell life may be expected. Loads in either tension or compression up to three times these capacities can be carried without mechanical failure.

Accuracy of load measurement is within ±¼ percent of full range at any load within rated capacity. The load cells range in size, the largest being 6½ in. in diameter and 11½ in. high. Input current may be a-c or d-c at 4 to 8 volts.

Baldwin-Lima-Hamilton Corp., Philadelphia, Pa.

Circle No. 28 on Reader Service Card

CAST IRON WELDING AND BRAZING ROD, copper coated, flows out better, makes a denser deposit, and is more easily machined, it is claimed, than other cast iron rods. Use of critical material, has been reduced. It can replace nickelbase welding alloys. All-State Welding Alloys Co., Inc., 273 Ferris Ave., White Plains, N. Y.

VARIABLE SPEED TRANSMISSION is designed for input of 1,200 and 1,800 rpm without spring loading. Operation is claimed to be cool, quiet and efficient. Speed may be changed while running. Units are available in sizes of ½ to 1½ hp. Graham Transmissions Inc., 3754 N. Holton St., Milwaukee 12, Wis.

THERMOSTATS for appliances requiring sensitive precise control feature an electrically independent bimetal that does away with artificial cycling and "jitters" and operate with a snap action that is said to prevent arcing and prolong contact life. Stevens Mfg. Co., Inc., 69 S. Walnut St., Mansfield, Ohio.

CONTINUED ON PAGE 240

For FULLEST protection

against shorted wiring — use NEW T & B Self-Insulated Sta-Kon Terminals... SAVE AN EXTRA INSULATING OPERATION

NOW... end the risk of shorts between closely-mounted terminals—and do it the quick, economical way—by using T & B Self-Insulated Sta-Kon Terminals.

Metallic portion of these new components retains all the proved-over-the-years advantages of the Sta-Kon design—high conductivity, low contact resistance, lastingly strong grip on wire. The insulation—a special nylon formula which forms an integral part of the terminals *as shipped* and *as assembled*—absolutely prevents metal-to-metal contact between adjacent terminals. Self-Insulated Sta-Kons do away with the need for separate insulating sleeves . . . and save an extra insulating operation.

MANY INSULATION PLUSES

The insulation, selected after exhaustive tests as the best material available for severe service, combines exceptionally high impact strength with light weight. Its mechanical and electrical qualities are unaffected by installation. It successfully withstands the action of gasoline, naphtha, hydraulic fluids, many other chemical agents . . . as well as the effects of high temperatures.

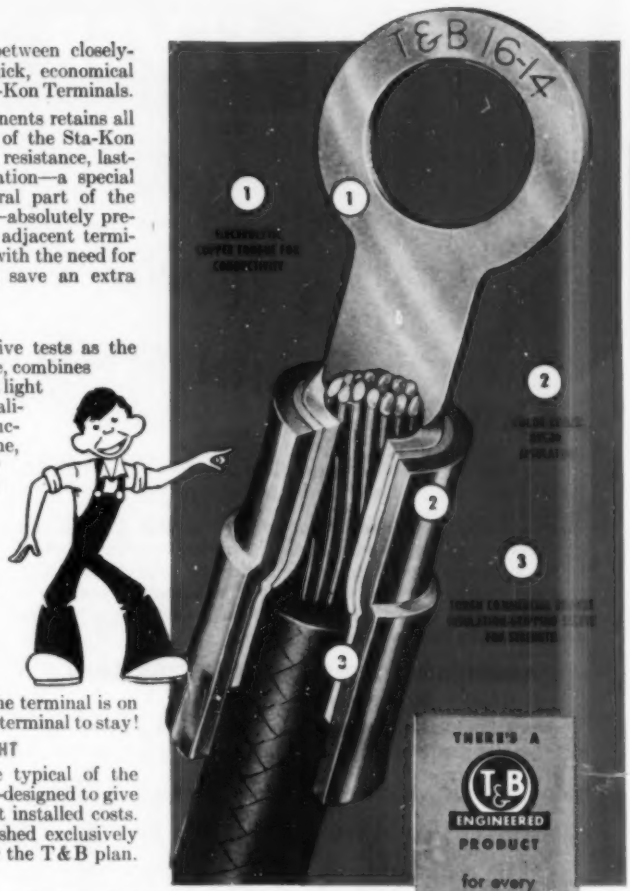
Insulation is *molded* for permanent dimensional accuracy . . . *color coded* for easy identification . . . *translucent* for visual inspection of assembly.

SIMPLE, SURE INSTALLATION

A single operation with Shure Stake Tools* *simultaneously* stakes terminal to wire with terrific pressure, and grips the insulation permanently in place. The terminal is on the wire to stay; the insulation is on the terminal to stay!

ENGINEERED RIGHT... DISTRIBUTED RIGHT

Self-Insulated Sta-Kon Terminals are typical of the many T & B quality fittings recently re-designed to give you outstanding performance at lowest installed costs. Like all T & B fittings, they're furnished exclusively through local T & B distributors under the T & B plan.



THERE'S A T&B ENGINEERED PRODUCT for every wiring job in the complete T & B line of fittings for all conductors and raceways.

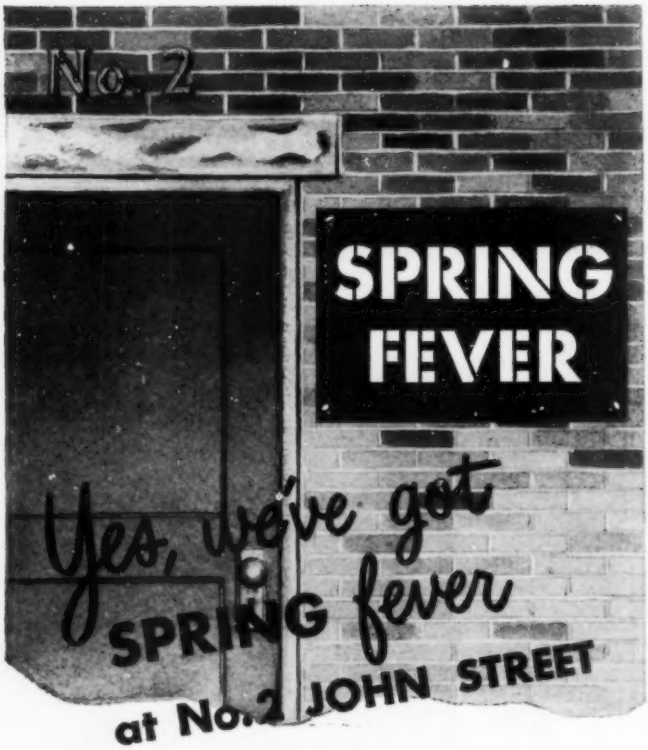
SHURE-STAKE HAND TOOLS exert more than 2,000 pounds staking pressure (compared with 800 pounds for ordinary tools.) Once pressure has been applied, jaws cannot be opened until dies have closed all the way home to exert full pressure. Air operated tools also available, in hand-held and bench-mounted types.

THE THOMAS & BETTS CO. INCORPORATED

16 Butler Street, Elizabeth 1, New Jersey

MANUFACTURERS OF ELECTRICAL FITTINGS SINCE 1899
ORIGINATORS OF SELF-INSULATED SOLDERLESS TERMINALS IN 1935

Our Field Service Engineers are ready to help you on special fittings problems. Ask your nearest T & B wholesaler to arrange to have one get in touch with you.



. . . and we've had it for more than 60 years . . . a burning ambition to make constantly better springs.

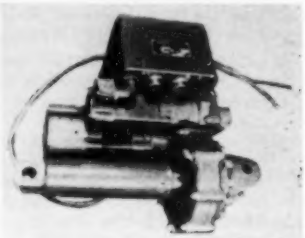
As long-time specialists in hot or cold wound springs, our engineers are often instrumental in helping people like yourself improve product performance and reduce production costs. Our old customers (and we hope you will become one) have learned to look to No. 2 John Street as a thoroughly reliable and unusually prompt source of supply.

AMERICAN-FORT PITT SPRING DIVISION
H. K. Porter Company, Inc.
No. 2 John Street, McKees Rocks, Pa. (Pittsburgh District)

AMERICAN-FORT PITT
SPRINGS

Motor Unit Powers Aircraft Stabilizer Surfaces Control

Automatic pilot control as well as manual control of the stabilizer surfaces on turboprop and jet aircraft is provided by dual motor power units. Each of these units is a complete actuator assembly incorporating a 1/10 hp and 3.3 hp motor operating through individual gear reductions to give a drive rate of 6/100 in. per sec and 7/10 in. per sec to the screw jack. Normal operating load of the assembly



is 11,000 lb. Static load is 80,000 lb. The small motor operates almost continuously under control of the automatic pilot. The 3.3 hp motor provides for pilot control at a higher rate for maneuvering. The complete actuator operates on 28 v and has overload and limit switches, radio noise filter, position indicator and non-jamming stops.

A similar dual motor power unit incorporates a 1/15 hp continuous duty motor for automatic control and a 3½ hp motor for manual control. It also provides a large power source for maneuvering and a small power source for trimming flight in the same assembly.

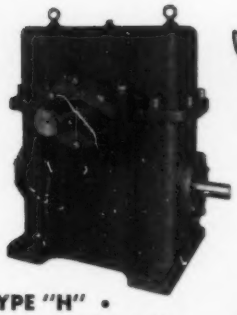
Electrical Engineering & Mfg. Corp., 4612 W. Jefferson Blvd., Los Angeles, Calif.

Circle No. 29 on Reader Service Card

Motor Starter Protects Personnel and Machine

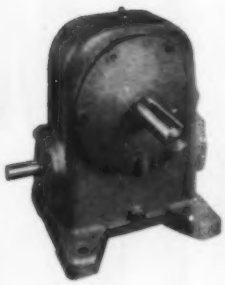
Protection of operating personnel as well as the connected machine is stressed in a motor starter recently marketed. With ratings up to 600 v, 7½ hp polyphase, 5 hp single phase; or 220 v, 1½ hp d-c, it starts, stops and provides overload protection for single phase, polyphase and d-c motors.

The self indicating handle, interlocked cover that prevents opening unless the starter is "off", and safety latch to lock starter "off" during servicing are protection features for per-



D.O.James

ESTABLISHED 1888



TYPE "H" •

Horizontal or Vertical Drive—Each drive type comes in 15 sizes, with ratio ranges of 5.6:1 to 100:1 and from .06 to 206 horsepower.

TYPE "S" •

Horizontal or Vertical Drive—Each type available in 8 sizes, ratio range of 5.66:1 to 100:1 and from .04 to 15.6 horsepower

for the Best in

WORM GEARS AND WORM GEAR REDUCERS

MOTORIZED •

Horizontal or Vertical Drive—Each drive type comes in 11 sizes, has ratio range of 5.6:1 to 100:1, with ⅛ to 30 horsepower, driven speeds of 310 r.p.m. to 17.4 r.p.m. Vertical drive slow speed shaft extends either upward or downward.

DOUBLE •

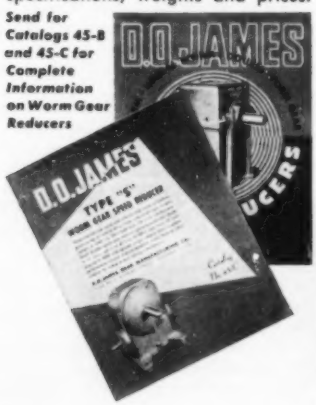
Horizontal or Vertical Drive—Each drive type available in 13 sizes, ratio range of 130:1 to 10000 and from .004 to 59.7 horsepower. Vertical drive slow speed shaft extends either upward or downward.

WORM GEARS

Generated on tangential feed hobbing machines by tapered and ground hobs. Made from 1" to 100" in diameter and from 24 DP to 1 DP.

Catalogs are available to users of Gears and Gear Reducers—containing valuable engineering data, specifications, weights and prices.

Send for Catalogs 45-B and 45-C for Complete Information on Worm Gear Reducers



D. O. JAMES Worm Gears and Worm Gear Reducers are designed and manufactured to have maximum inbuilt strength and to assure dependable *on-the-job* performance. The many and repeated installations of these reducers testify to their operating superiority and adaptability.

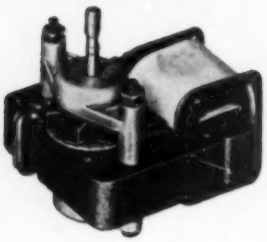
D.O.James GEAR MANUFACTURING COMPANY

1140 WEST MONROE STREET • CHICAGO, ILLINOIS

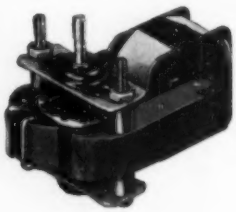
SINCE 1888—MAKERS OF ALL TYPES OF GEARS AND GEAR SPEED REDUCERS

SMALL MOTORS

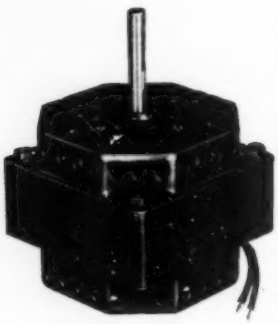
WITH A BIG REPUTATION



MODEL A . . . 1/125 to 1/200 H. P.
2-pole, shaded pole induction motor. Features include novel bearing construction which insures rigid and permanent alignment of motor shaft...oilless bearings.



MODEL C . . . 1/250 to 1/500 H. P.
2-pole, shaded pole induction motor. Features include accurately aligned motor shaft . . . oilless bearings.



MODEL D . . . 1/50 to 1/100 H. P.
4-pole, shaded pole induction motor. Features include scientifically designed air intake . . . dual cooling fans . . . self-aligning, oilless sleeve bearings.

It's a time-proved reputation, too . . . for dependability . . . quiet operation . . . and trouble-free performance. Each of these *Smooth Power* motors is engineered and built to exacting quality standards . . . your final assurance of long-lasting customer satisfaction.

Write *today* for complete information and specifications.

THE GENERAL INDUSTRIES CO.
DEPARTMENT D • ELYRIA, OHIO

sonnel. Positive motor-protection is provided by the quick make, quick break, over center toggle mechanism, by de-ion arc-quenching, and by the bimetallic disk-type thermal overload relay. Straight-through wiring is designed to facilitate installation and servicing, and Bonderized enclosures prevent blistering, flaking and corroding.

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh, Pa.

Circle No. 30 on Reader Service Card

Burner Atomizes Oil To Insure Complete Combustion

Steam under pressure is utilized by this burner to atomize oil into small particles which are then discharged through rapidly rotating orifices and thrown outward into a cylindrical sleeve of air. This air-fuel mixture is projected into the furnace by a fan, which is rotated by the jet reaction of the steam-atomized oil. This violent mechanical mixing of the atomized oil and air brings the oxygen molecules together with the hydrocarbon molecules of the fuel to give, it is said, rapid and complete combustion and, consequently, a very short flame pattern. Since the fan's power requirement coincides with the power developed from the reaction force of the steam atomized oil, an increase in the amount of fuel speeds up the fan, thus automatically maintaining the proper fuel-air ratio.

A number of advantages are claimed for this method of burning oil. First, boiler ratings can be increased because

UNBRAKO CAP SCREWS ARE USED ON . . .

. . . *This* LIMITORQUE VALVE CONTROL

Because design and assembly were important factors in the production of this Philadelphia Gear Works *LimiTorque* Control, UNBRAKO Socket Head Cap Screws were specified.

UNBRAKO's *knurled*, slip-proof heads permit more expeditious handling, save assembly time. UNBRAKO's greater strength provides extra safety for the user, and internal wrenching enhances the functional, attractive design.

Why not investigate the advantages of UNBRAKO for *your* products? Write today for samples and information.

Knurled Head Socket Cap Screws
Flat Head Socket Cap Screws
Self-Locking Socket Set Screws

SOCKET **UNBRAKO** SCREWS

Knurled Head Stripper Bolts
Precision-Ground Dowel Pins
Fully-Formed Pressure Plugs

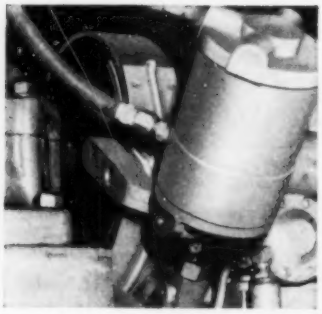
SPS STANDARD PRESSED STEEL CO.

JENKINTOWN 28, PENNSYLVANIA

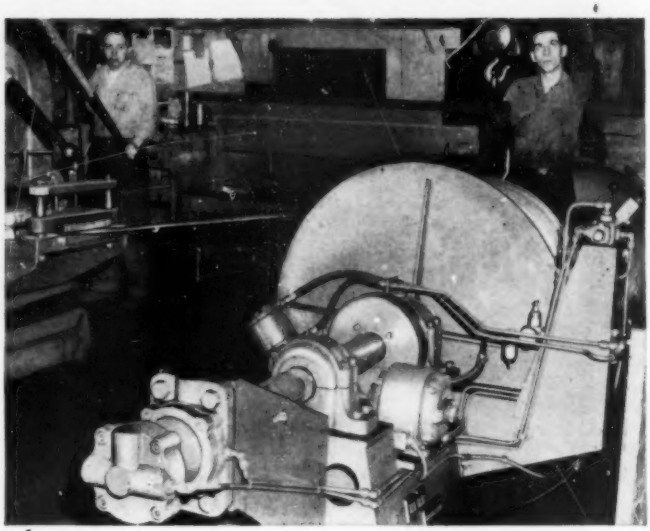
Effective Control Without Overheating!

TDA BRAKES

SOLVED THIS PROBLEM FOR GOOD!



Too much heat—not enough control! That was the problem of the Brainard Steel Company until they equipped their "Pay-out Reel" with a TDA Duo-Grip Brake! This machine serves the purpose of holding a coil of steel which is drawn into a cold rolling mill and then re-coiled. The brake is used to check the unwinding coil and, therefore, is constantly engaged and constantly generating heat. The open brake drum area of the TDA Brake allows for rapid heat dissipation—adding to braking efficiency and eliminating a possible fire hazard! Moreover, this sturdy brake has proved to be simpler to maintain.



WHATEVER *YOUR* BRAKING PROBLEM— TAKE IT TO TDA BRAKE DIVISION!

Controlled rotation is often the key to high production output! Dependable, responsive brakes eliminate breakdowns—keep machines humming at a steady clip! Recognizing this important fact, alert manufacturers are standardizing on smooth, efficient TDA Brakes! They're taking full advantage of the more than 40 years of experience offered by TDA Brake Division—experience concentrated in a highly competent staff of brake technicians. Let TDA Brake Division put its forces to work in developing the specific type of brake you need to meet your exact requirements! Mail the coupon below for more information on how TDA Brakes can be applied to your product.

Here Are A Few Of The Many Products Which Can Be Equipped With TDA Brakes

Centrifuges • Compressors • Conveyors • Cranes Cream Separators • Diesel hook-ups • Dry cleaning machinery • Extractors • Hoists • Industrial electric trucks • Lathes (automatic) • Looms (textile) • Lumber mill machinery • Machine tools • Materials handling equipment • Motors • Packaging machinery • Paint mixers • Press brakes • Printing presses • Rolling mills • Shears • Warpers (textile) • Welding positioners • Winches • Automotive • Farm equipment Earth moving equipment • Construction equipment Public transportation.

IF IT ROTATES WE CAN BRAKE IT

TDA BRAKE DIVISION—DEPT. A-2
ASHTABULA, OHIO

Please mail brake information on these applications.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

TIMKEN Detroit BRAKES

TDA BRAKE DIVISION
THE TIMKEN-DETROIT AXLE COMPANY
ASHTABULA, OHIO.

The Accepted TDA Standard

TRADE MARK REGISTERED

the furnace space no longer need serve for both mixing and combustion. Second, fuel efficiency is improved because more heat is absorbed from the same amount of fuel. Third, the short flame pattern does away with hot spots resulting from flame impingement and delayed combustion. Fourth, no forced draft equipment is needed and stack requirements can be reduced. Fifth, since atomizer tips are air cooled to a point well below the coking temperature, coking of atomizers is reduced with the resultant decrease in downtime and maintenance.

Coppus Engineering Corp., Worcester, Mass.

Circle No. 31 on Reader Service Card

Bronze Solenoid Shut-Off Valve

Here is a line of corrosion resistant, solenoid operated, shut-off valves that control fluid pressures from 0 to 225 psi. No levers, pilot or other form

of indirect application are used. They may be mounted in any position and inspected or serviced without disturbing the piping. Sizes range from ¼ to 2 in. standard pipe diameters. Constructed of Naval Bronze, these valves feature positive seal, ports in line, and only one moving part.

Airmatic Valve, Inc., 1643 E. 40th St., Cleveland, Ohio

Circle No. 32 on Reader Service Card

Counter Can Be Reset to Zero

This electric counter can be reset to zero by turning the reset knob backwards. Each sweep of the finger

- **Permits Higher Operating Speeds**
- **Assures Cooler, Smoother Running**
- **Provides Longer Wear Life**

Sunnen Honing Machines produce holes that are geometrically true, with a cross-hatched pattern and any desired surface finish down to virtual base metal. There are no high spots or ridges to break through the oil film and create "hot spots"... no torn, gouged or smeared metal to flake off and wear away. There's just a very smooth surface with tiny criss-cross valleys for holding a uniform film of lubricant. The result is less wear, and longer, quieter, cooler operation.

Sunnen Honing Machines

- *hone any hole from ¼" to 2¾" in diameter*
- *hone practically any metal of any hardness, as well as plastics and ceramics*
- *hone open and blind holes, plain or with keyways*
- *produce accuracy to .0001" or better, with surface finish from 80 to 2 micro-inches as required*
- *need no jigs or fixtures*
- *can be operated with unskilled labor*

SUNNEN
PRODUCTS COMPANY
7974 Manchester Avenue
St. Louis 17, Missouri
Canadian Factory —
Chatham, Ontario

Factory trained honing engineers are available for consultation, without obligation. Send the coupon for more information.

603

SUNNEN PRODUCTS COMPANY
7974 Manchester Ave., St. Louis 17, Mo.

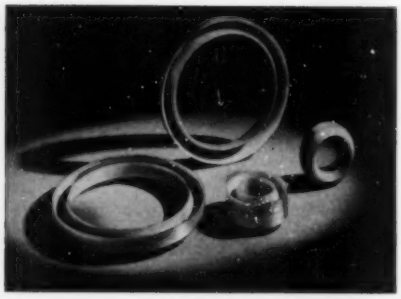
☐ Please send complete information on Sunnen Honing. ☐ Have Your Representative Call.

Name.....Dept.....

Company.....

Address.....

City.....State.....

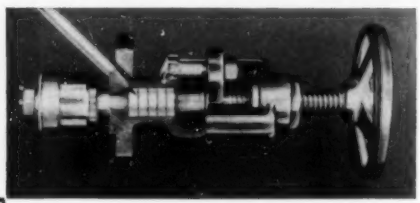


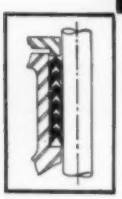
CHEMICAL-PROOF TEFLON PACKING

V-Ring Design—
Seals at Low Gland Pressure
Reduces Torque on Spindle

Here's a Teflon packing (Chemiseal #810V) that's mechanically more flexible, more resilient than any design to date. Note cross section: each ring acts as a wedge against the next, so that even a light gland pressure forces the ring lips tightly against spindle and stuffing box. (As working pressure increases, sealing force increases correspondingly.) Light gland loading, plus Teflon's natural slipperiness, means minimum torque on the spindle—an almost frictionless packing that won't "freeze" a valve no matter how long unoperated.

V-Ring wedge action permits easy flexing of this Teflon packing.





Being made of solid Teflon, Chemiseal #810V packing is *chemically inert*—no corrosion, no contamination. These packings are tough and suitable for —150° F. to 550° F. Ideal for hand-, air-, or motor-operated valves, for emergency shut-off service, for slow-speed reciprocating pumps. Needs no more attention than a packless valve. Makes a permanent installation in steam and water service. Send for Catalog No. 810V.

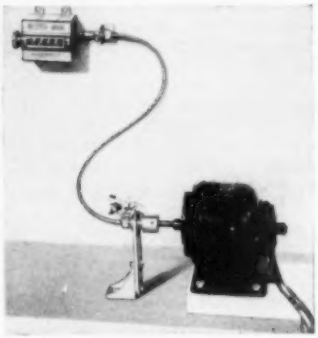
Teflon Products Division

UNITED STATES GASKET CO.

649 N. 10th Street • CAMDEN, NEW JERSEY

deducts 20 to 30 counts; resetting to zero from 999 requires about 20 seconds.

The mechanism is enclosed in a metal case with a plastic window. It is actuated by electric impulses that



may originate from any suitable switch, relay or photoelectric unit. Installation may be at any distance from the actual source of count.

Models can be furnished with 1, 2, 3 and 4 digits for 6, 12, 24, 48 or 115 volts on either 60 cycle a-c or d-c current.

Production Instrument Co., 702–10 W. Jackson Blvd., Chicago 6, Ill.

Circle No. 33 on Reader Service Card

Metal Plus Chemical Equals Dry Bearings

Chemalloy is an alloy of metals and chemicals produced by bringing together molten metal and a wet mass of chemical by a process that minimizes explosion and other hazards. This alloy has a number of interesting properties. First, its anti-seizing qualities are such that dirt and other foreign matter do not seize but cut fine grooves and wear away slowly without interfering with the bearing surfaces. In tests where a chemalloy surface was run in contact with a thick brass rod, the brass remained cool whereas the chemalloy became hot. Second, it is self lubricating. Chemicals work out to the surface at friction points and act as a lubricant. Two chemalloy surfaces may be run together with or without lubrication. Moreover, for qualities with added lubricant, a lubricant, either oil or water, may be added. It will not work away from the friction points.

Third, chemalloy is said to be excellent for die casting and can also be used for sand castings. Precision work is possible with either method. Fourth, in machining no coolant is

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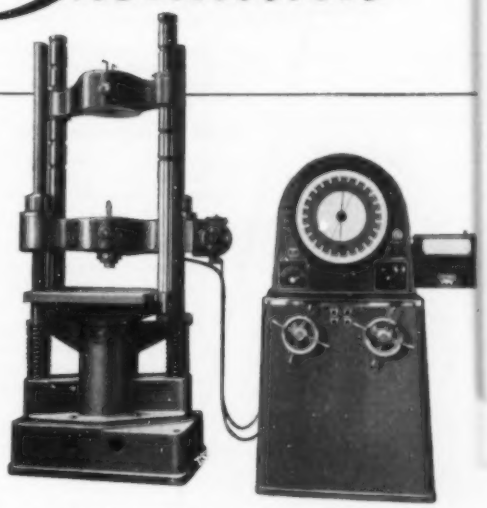
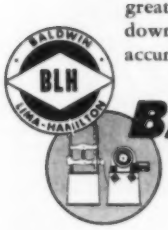
THE SEAL OF *Distinction*

Baldwin-Tate Emery
Universal Testing Machines



The change in corporate name does not affect the quality, the enduring precision, of the unusual advanced features offered by these world-famous machines.

Tate Emery weighing system is entirely separate from the loading system. Servo drives provide an outside source of power, overcomes drag, provides excess energy to operate auto-controls. The multi-range system permits selection of range during test. 200 to one range or greater . . . accuracy of ½% guaranteed down to 20% of each range . . . A.S.T.M. accuracy guaranteed down to 10% of each range. Sensitivity has been demonstrated at 1 lb. in a million. Zero essentially positive. Negligible hysteresis, creep or temperature errors. Complete calibration and maintenance service. Installation by a qualified Baldwin field engineer.

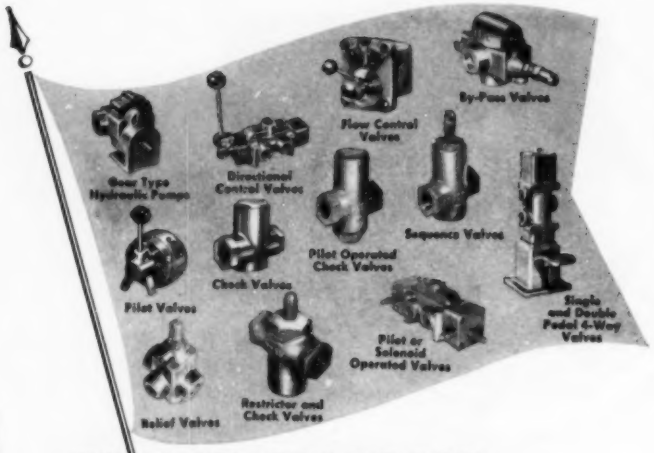


BALDWIN-LIMA-HAMILTON

TESTING HEADQUARTERS

EDDYSTONE DIVISION, BALDWIN-LIMA-HAMILTON CORPORATION, PHILADELPHIA 42, PA.

In Canada: Peacock Bros., Ltd., Montreal, Quebec



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required. Cutting speeds of 1,800 rpm cause little wear of the cutting tool. The cuttings come off as a fine flake or powder leaving a natural polish and lustre on the piece.

Fifth, it is corrosion resistant to salt spray and shows no visible effect after 1½ hours, and slight effects after 12 hours. Salt air and weather can be withstood indefinitely. Sixth, chemalloy can be plated with such metals as nickel, silver and copper by conventional methods. It has been successfully weleded with pot metal. Seventh, its composition can be altered to give various tensile strengths. Samples have been tested at 50,000 psi in tension and 100,000 psi in compression.

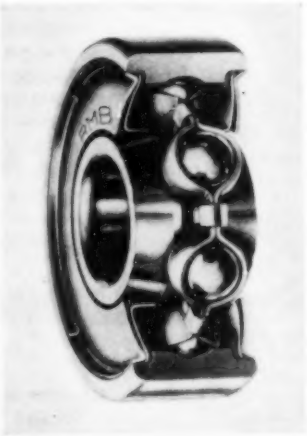
Transport Products Corp., 120 S. Campbell St., Louisville, Ky.

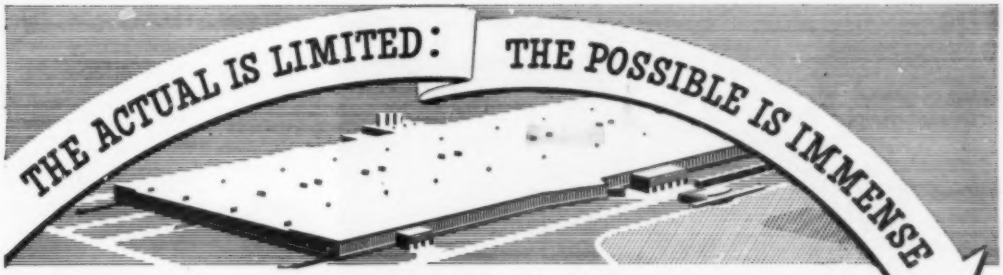
Circle No. 34 on Reader Service Card

Ball Bearing Is Sealed Without Mechanical Contact

The advantages of a sealed ball bearing and the freedom of rotation of an open bearing are combined in a ball bearing which is sealed without mechanical contact between its stationary rotating members. In this bearing a capillary chamber is formed by the cylindrical extruded section of the inner cover and the tapered section of the inner race. At that point a permanent capillary film of oil seals the bearing.

The external surfaces of the bearing can be chrome plated. The combination of the capillary seal and the plating produces a corrosion resistant bearing. These sealed bearings are available in bore sizes from 3 mm (0.1181 in.) to 8 mm (0.3150 in.) and cor-





NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

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DESIGNS ORIGINEERED IN WELDED STEEL ARE ALWAYS LOWER IN COST

WITH welded construction, new product shapes can be created, utilizing the inherent low cost economies of steel. There is less cost per pound with steel. Fewer pounds are needed. Furthermore, each pound of metal can be applied where it will do the most good.

Convention-bound designs can be completely discarded. Welding enables the engineer to exercise his imagination . . . to create more efficient product shapes . . . to get better distribution of metal. He can use either standard rolled steel shapes or fabricate his own sections.

The "thought starter" sketches show how a typical section may be developed to save material and cut labor cost. Your Lincoln Welding Engineer will gladly demonstrate how these basic cost-saving principles of welded steel can be applied to your products. Simply write The Lincoln Electric Company, Cleveland 1, Ohio.

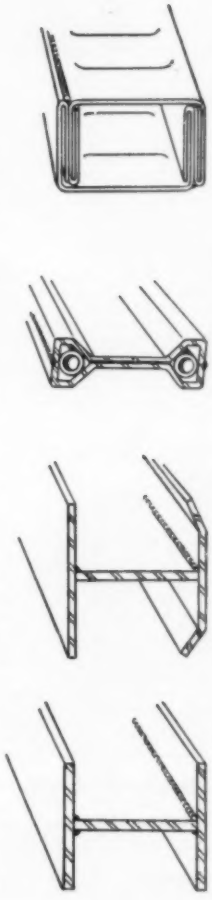

Fig. 3. "I" section. Higher strength to weight ratio under lower loading conditions is gained through better distribution of metal in outer areas. Needs 85% less metal than Figure 1 . . . 40% less metal than Figure 2.

Fig. 4. Bottom flange of "I" section can be brake formed from light material and Automatic Lincolnwelded on one side only to web. Saves 10% metal and 50% fabricating cost over section shown in Figure 3.

Fig. 5. Pressed steel section formed from light gauge metal. The formed half sections are assembled over steel tubing and Automatic Lincolnwelded at outer edges. Weighs 50% less than Figure 1.

Fig. 6. Box section is fabricated from lighter gauge sheet than Figure 5. Flanges are folded metal to increase amount of material at outer edges. Web is corrugated to achieve maximum strength per pound. Weighs 5% less than Figure 5. Lincolnwelded for lowest fabrication cost.

the ACTUAL

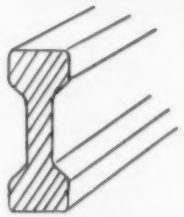

Fig. 1. Cross section through an iron cantilever beam designed to resist a bending moment.

increasing the YIELD

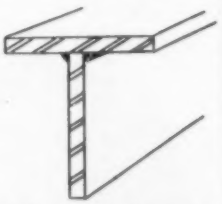

Fig. 2. Tee section through comparative beam fabricated by welded steel. Needs 75% less metal than Figure 1 to achieve equal strength in bending.

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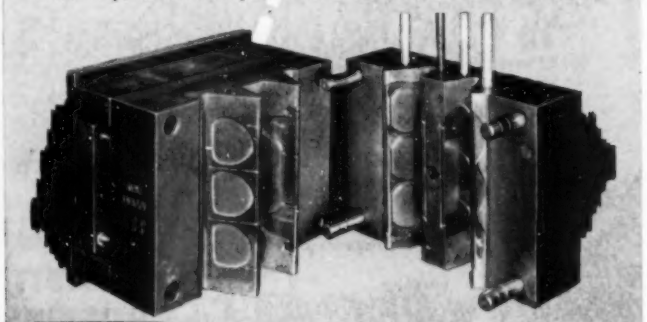
MADE IN MOLDS OF

SPEED ALLOY

HOT ROLLED ALLOY STEEL PLATE

Federal Tool Corp., Chicago, selected Speed Alloy for the die that molds the holder for this attractive shaker group—made for International Minerals & Chemical Corp., producers of Accent, famed for accentuating food flavors. The accent was on speed, economy and a mold that would stand up on long runs. Speed Alloy—one of the time saver SPEED STEELS—ably filled the bill.

Like so many plastics molders, Federal Tool—one of the largest producers of molded housewares and closures—has enjoyed repeated success with Speed Alloy. They like its hardenability, excellent polishing characteristics, ability to withstand relatively high compression, availability in large plate sizes (up to 72" wide and 6" thick) and moderate price. Besides plastic molds and zinc die casting dies, Speed Alloy has been widely adopted by many industries for countless machine parts. Contact your nearest source or ask for Bulletin 905.



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responding outside diameters of 10 mm (0.3934 in.) to 22 mm (0.8661 in.). Two smaller sizes with OD of 0.2362 and 0.3150 will be available shortly.

Landis & Gyr, Inc., 104 Fifth Ave., New York, N. Y.

Circle No. 35 on Reader Service Card

Foot Switches Perform One or Two Operations

These foot switches are available in two models. One, which may be wired normally open or closed, is a single pole, double throw momentary contact switch rated at 5 amp at 110 or 250 volts. The other is identical in size and appearance but provides two switching operations activated by one treadle. A partial

downward stroke actuates one contact, either opening or closing it. Additional pressure actuates a second contact that either opens or closes a second circuit. It is rated at 5 amp at 110 or 250 volts.

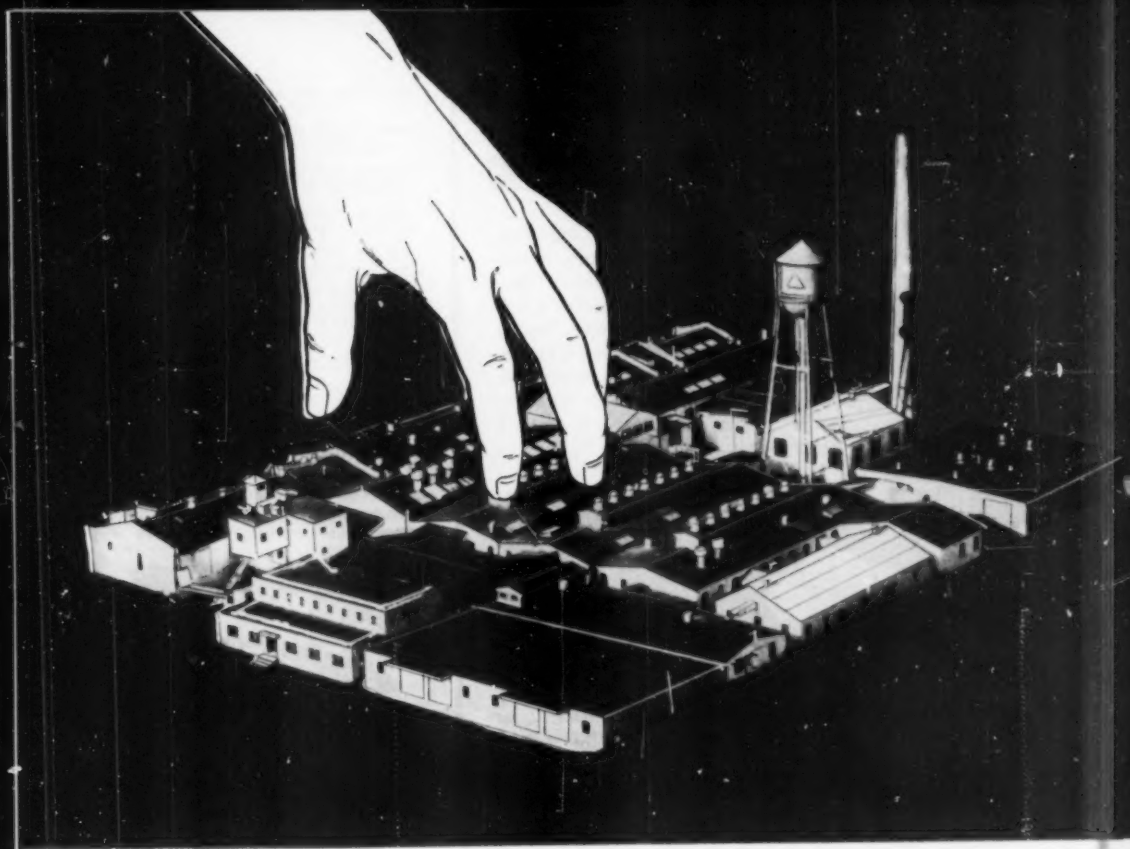
Simonds Machine Co., Inc., Southbridge, Mass.

Circle No. 36 on Reader Service Card

High Strength Aluminum Rivets

Aluminum alloy rivets in sizes of $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1 in., said to be stronger than any heretofore available, are offered on an experimental basis for use on heavy aluminum structures. All but the largest size can be hot driven with hand pneumatic hammers. The 1 in. rivet must be squeeze driven.

Experience has indicated that the following characteristics are obtainable: an average shear strength of 38,000 psi within 2 weeks after driv-



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Our engineering people are here for the purpose of advising you on the proper use of molded plastics. The use of this service involves no obligation. Just drop us a line if you think we can be of assistance to you.

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COLD MOLDING of electrical parts requiring high heat resistance.

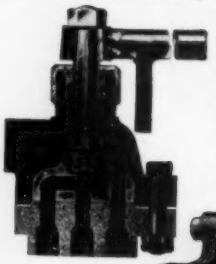
LOW-PRESSURE MOLDING . . . a relatively new development especially suitable for short runs of large, lightweight pieces.

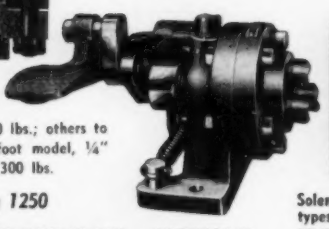
Aico plastics

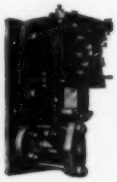
NICHOLSON CONTROL VALVES SET

RECORDS for LONG LIFE

In a wide range of plants—steel, metal working, processing, etc.—many Nicholson cylinder control valves have now been in continuous service for over 25 years. Their capacity for long leak-free service is confirmed by repeated installation records showing Nicholson valves actually become tighter with use. This is because their non-corrosive flat discs tend to lap themselves on the seats. For air, gas, oil, steam, water.







Above, lever model, ¼" to 2½", press. to 500 lbs.; others to 5000 lbs. Right, foot model, ¼" to 1½", press. to 300 lbs.

Solenoid and motor types, ⅛" to 2½"; press. to 375 lbs. Many metal combinations.

Catalog 1250

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- ★ No false contacts
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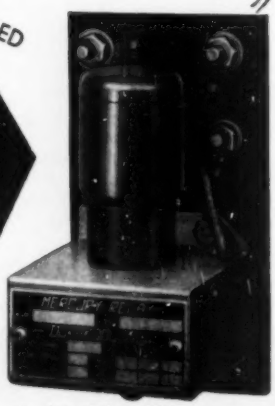
Durakool
STEEL MERCURY TIMERS



The steel-clad "fixed time" Durakool timer-relay operates in "sealed in" hydrogen under pressure, with mercury to mercury contacts. Timing is tamperproof. Non-breakable and built for millions of contacts. Fixed time delays available from 1/6 to 20 seconds, either normally open or normally closed action.

See Telephone Directory for Local Distributor or write Durakool, Inc. Elkhart, Indiana

Send for Bulletin 800

sistance with normal paint protection.

The wide heating range is advantageous in field work and shop fabrication but the required driving pressure increases as the temperature is decreased within this range. Driving the rivets at temperatures above the upper limit of 975 F may result in cracked rivet heads.

Aluminum Co. of America, 801 Gulf Bldg., Pittsburgh 19, Pa.

Circle No. 37 on Reader Service Card

Accuracy of Recorder Is 0.25 Percent of Scale

This strip chart recorder is a deflection type, electronically operated unit capable of detecting changes in a

measured variable with an accuracy of ¼ of 1 percent of the scale reading. Results like this have hitherto been obtainable, it is pointed out, only through the use of potentiometric or null type systems.

Up to six permanent records can be made on one chart. Measurement may be obtained from thermocouples, radiation detectors or other sensing units producing electric signals.

Wheelco Instruments Co., 847 W. Harrison St., Chicago, Ill.

Circle No. 38 on Reader Service Card

Electric Counter Operates At Speeds Up to 1,000 Counts Per Minute

Identical in design and appearance are two companion models of an electric counter. The smaller, which measures $1\frac{3}{8}$ in. wide, $2\frac{9}{16}$ in. high and $3\frac{3}{4}$ in. long, is for light applications where reading is done at close range. It operates at speeds up to 1,000 counts per minute. The larger, $2\frac{3}{8}$ in. wide, $4\frac{7}{32}$ in. high and 5 in. long, is suitable for heavy industrial needs

(Advertisement)

POWDER METALLURGY

PARTS KEEP OIL FILM UNBROKEN

The method of lubrication used in powder metallurgy parts made of "COMPO" and "POWDIRON" assures a constantly maintained surface oil film for long periods of time—frequently for the useful life of the machine.

The microscopic pores in the structure of "COMPO" and "POWDIRON" bearings and parts form an oil reservoir, in many cases holding ample lubricant for thousands of hours' operation without renewal. Renewal of the lubricant is accomplished by simply applying it to any surface of the bearing or part. The microscopic pores will quickly soak up the lubricant.

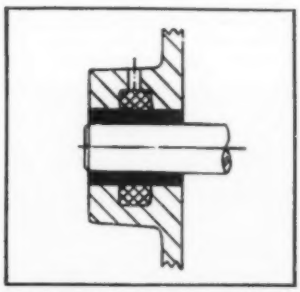
RUNNING CONDITIONS

When the machine is operating, any increase in friction caused by a deficiency of lubricant between bearing and shaft, or between meshing parts such as gears, immediately results in a temperature rise. Additional oil is fed to the surface at once, to restore correct lubricating conditions.

An important point is that oil is fed to the surface only as needed, and is drawn back into the pores when the need is over. Hence there is no danger of the oil spatter so objectionable in food, paper and textile machinery.

DESIGNING FOR ADDITIONAL LUBRICATION

When additional lubrication is required (and it often is both for long service requirements and to give an added safety factor)—provision can be made in the design of the housing for an annular groove holding saturated felt and surrounding the bearing.



Provision for additional lubrication of "COMPO" and "POWDIRON" bearings can be made by the incorporation of oil-soaked felt in a retaining groove, as shown above.

Lubrication recommendations for specific applications may be obtained from Bound Brook Oil-Less Bearing Company, Bound Brook, N. J.

EFFICIENT LUBRICATION
is one of the 6 outstanding advantages of

"COMPO"® and "POWDIRON"® BEARINGS AND PARTS

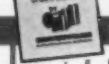
THE 6 OUTSTANDING ADVANTAGES OF "COMPO" and "POWDIRON" are:

1. Efficient lubrication
2. Extreme quietness
3. Low installation cost
4. Low operating and maintenance cost
5. High load capacity at high speeds
6. Long, uninterrupted service

The lubricant stored in "COMPO" and "POWDIRON" bearings and parts will not last forever—but it often does last for thousands of operating hours. When lubricant renewal is needed, just bring oil into contact with the bearings or parts—the pores lap it up like a sponge. Put *"COMPO"* and *"POWDIRON"* to work wherever maintenance is *difficult* or *neglected.*

Write on your company letterhead for latest list of stock sizes of "COMPO" bearings—consult our engineering department on special requirements.

Send for this ***FREE*** *Booklet*



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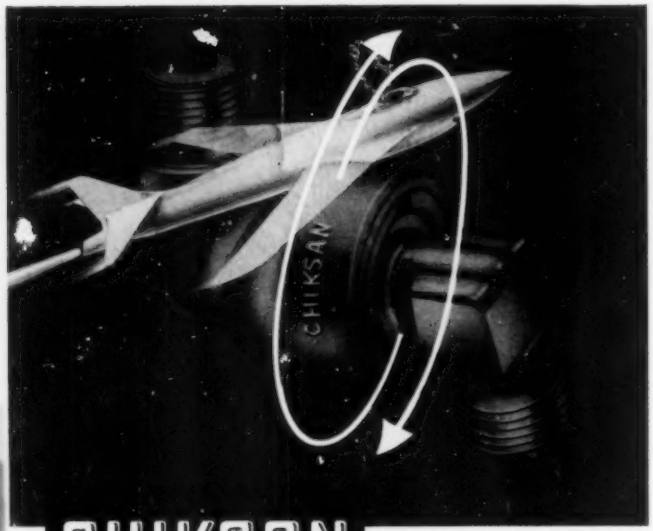

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FUEL DUMP CHUTES • WING FOLD • FLIGHT CONTROL • OXYGEN LINES • HYDRAULIC LINES, LANDING GEAR • FUEL AND OIL TANK SWING INTAKES

....a great name at MACH 1

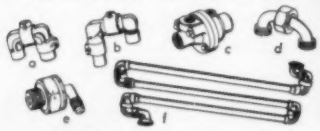
No need to waste precious time... and money... on design, mock-up and testing to develop Swivel Joints for your flexible lines. CHIKSAN *Ball-Bearing* Swivel Joints are proved *now* for all kinds of applications.

With CHIKSAN Swivel Joints, you can build flexible lines with all-metal tubing which permit tight bends and fit into limited space... lines which permit unlimited flexibility without drag or sag... lines which assure maximum safety and dependability under pressures to 3,000 psi. (to 15,000 psi. on industrial applications).

CHIKSAN performance is proved by the continued acceptance of leading Aircraft and Industrial manufacturers for applications in civilian and military equipment for use on land, on the sea and in the air.

1 Typical CHIKSAN installation on hydraulic lines for aircraft landing gear.

(a) Basic Type Swivel Joints – for pressures from 125 psi. to 15,000 psi. (b) High Temperature Swivel Joints for temperatures to 500° F., working pressures to 700 psi. (c) Rotating Joints for 150-lb. steam, brine, etc. For hot and cold rolls, tumblers, platens, etc. (d) Sanitary Swivel Joints for food processing, fruit juices, dairies, etc. (e) Hydraulic Swivel Joints for pressures to 3,000 psi. For aircraft, industrial and armored equipment. (f) Flexible Lines, designed and fabricated to meet specific requirements.



WRITE FOR CATALOG NO. 50-AH

Representatives in Principal Cities

2 Brake line installation on torque link in aircraft brake system.

CHIKSAN TRADE MARK REG.

CHIKSAN COMPANY AND SUBSIDIARY COMPANIES
NEWARK 2, N. J. BREA, CALIFORNIA CHICAGO 3, ILL.
CHIKSAN EXPORT COMPANY, 155 WASHINGTON ST., NEWARK, N. J.
WELL EQUIPMENT MFG. CORP., HOUSTON 1, TEXAS

BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

where distant reading is involved. The speed of this one is 800 counts per minute.

Totally enclosed in a case that provides compactness and rigidity, the counter is protected against dust and moisture. Either panel mounting or base mounting is suitable. Hardened steel working parts assure long life and dependability. Voltage fluctuations on normal industrial circuits have no effect on accuracy. Both models have 6 figure capacity and are resettable.

Durant Mfg. Co., 1929 No. Buffum St., Milwaukee, Wis.

Circle No. 39 on Reader Service Card

Small Pump Has Large Capacity

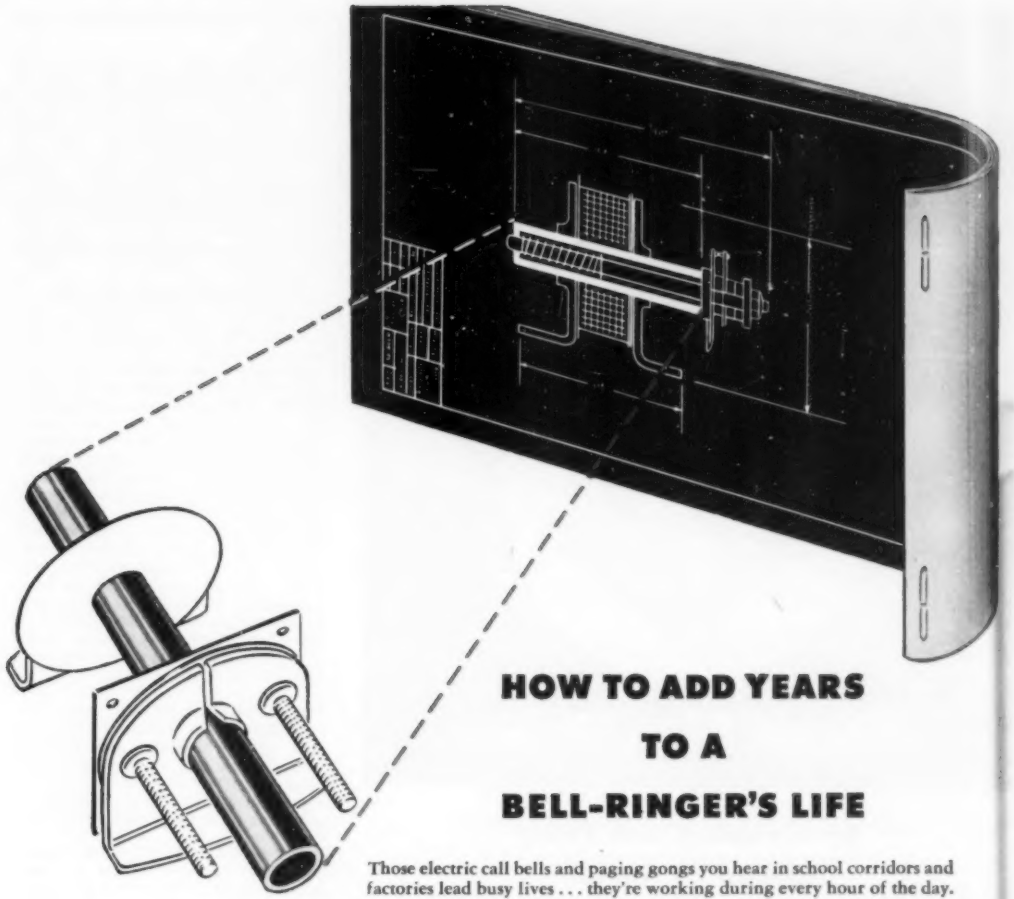
This pump is believed able to handle more liquid than any other of the same size and weight. It is less than 4 in. long and pumps 1.65 gpm at 1,750 rpm against pressures up to 150 lb per sq inch.

Made of Naval Bronze, the pump works in either direction and requires no lubrication. Eccentric pistons are made of resilient material that will

withstand oils or kerosene. It is available with or without flange-mounted motor.

Eco Engineering Co., 12 New York Ave., Newark, N. J.

Circle No. 40 on Reader Service Card



HOW TO ADD YEARS TO A BELL-RINGER'S LIFE

Those electric call bells and paging gongs you hear in school corridors and factories lead busy lives . . . they're working during every hour of the day.

To combat rapid wear in the operating mechanism, Sperti Faraday, Inc., switched to Republic ELECTRUNITE Stainless Steel Tubing for the plunger tube of the actuating solenoid. The life of this heart of the device has been doubled by the shift from a non-ferrous tube to Republic ELECTRUNITE Stainless.

Greater toughness to resist wear years longer was the primary reason that stainless steel got the job. But secondary benefits included greater strength to withstand a press-fit operation, the extra-close I.D. and wall tolerances of Republic ELECTRUNITE Tubing, high resistance to corrosion, and non-magnetic properties.

Somewhere in your product there may be a job that can be done far better by stainless steel . . . or exclusively by stainless steel. We'd welcome the invitation to put Republic's Tubing Specialists to work on that problem. When may we call?

REPUBLIC STEEL CORPORATION
STEEL & TUBES DIVISION
224 EAST 131st STREET • CLEVELAND 8, OHIO

Republic
REPUBLIC STEEL
ELECTRUNITE
STAINLESS STEEL TUBING AND PIPE

by keeping one jump ahead in design

The smaller the equipment—the more trouble from high inrush currents . . .

This portable telecast equipment first used a single pole supply line relay—but the high inrush currents the instant after closing, sometimes welded the contacts. Solution appeared to be to use a larger relay or to alter the equipment, increasing its size.

Then: Ward Leonard suggested a *heavy-duty midget* parallel contact relay—no larger than before—with poles paralleled and with silver-to-carbon contacts on one pole making contact before the silver-to-silver contacts close on the other pole.

Investigate Ward Leonard facilities for *variations* of standard designs to simplify your control.

WARD LEONARD ELECTRIC CO., 63 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY

Result-Engineered Controls

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

CATALOGS and BULLETINS

(41) POWER TRANSMISSION — Link-Belt Co. General Catalog 900, 1,295 pp. Material covered is grouped under 8 headings. A table of contents heads each group, and there is a complete index in the back of the book. Section 1 is made up of photographs that show where the company's products are used in the many industries it serves. Sections 2 through 7 are entitled respectively Chains and Wheels, Drives, Transmission Products, Process Machines, Conveyors and Auxiliary Products. Each product is pictured and data such as rating, dimensions, and characteristics are given. General engineering information makes up Section 8. It includes chain conveyor calculations, shaft and bearing load calculations, conventional formulas, equivalents and conversion of cu ft and tons per hour.

(42) RUBBER COMPOUNDS—Stalwart Rubber Co. Catalog 51SR-1, 16 pp. Contains tabulated data and descriptive matter pertaining to several types of rubber compounds, each designed for a specific use. Methods of producing parts from them are shown.

(43) CONVEYOR CHAIN—Chain Belt Co. Catalog 51–59, 4 pp., and Catalog 50–35, 12 pp. The first catalog shows some applications of a conveyor chain that can flex in both the horizontal and vertical plane. The second is an illustrated display of the more common types of conveyor chains and attachments.

(44) COPYING MACHINES—Charles Bruning Co., Inc. Booklet, 8 pp. Points out how a group of copying machines suited for all phases of business can cut costs and improve the production of drawings, instructions, orders and other paper work.

(45) HYDRAULIC STANDARDS—Miller Motor Co. Booklet, 16 pp. Latest edition of the Joint Industry Conference's Hydraulic Standards for Industrial Equipment. A cutaway view of one of this firm's hydraulic cylinders shows how these standards are met in its products.

(46) OIL BURNERS—Ray Oil Burner Co. Catalog, 159 pp. Divided into sections, the catalog opens with an illustrated discussion on how to choose oil burning equipment and goes on to describe one type of oil burner,

pump or auxilliary component. Illustrations show not only the oil burner itself but applications. There are also numerous charts of ratings, dimensions and other data. A final sections gives engineering specifications. Fully indexed.

(47) TRANSMISSIONS — Western Mfg. Co. 2 Catalogs, 2 pp. each. One displays a group of two speed automatic transmissions ranging from 1–50 hp used to supplement constant speed and multi speed motors and the other shows a 20 hp transmission and gives its dimensions and specifications.

(48) FLUID LINE COUPLINGS — Hansen Mfg. Co. Catalog, 40 pp. Cutaway views as well as photographs help to bring out the construction features of a line of couplings for pneumatic, hydraulic, oxygen, acetylene, steam and similar applications. Major dimensions and other data are given for each of the units. Other products shown are hose clamps, pipe and hose unions, valves, and similar components

(49) STRATEGIC MATERIALS — American Cladmetals Co. Booklet, 20 pp. Consists of a series of bar charts comparing the chemical composition of metal alloys with those of nickel and other stainless and heat resisting alloys. In Rosslyn alloys, a good part of the nickel, chromium and other hard to get materials are replaced with copper.

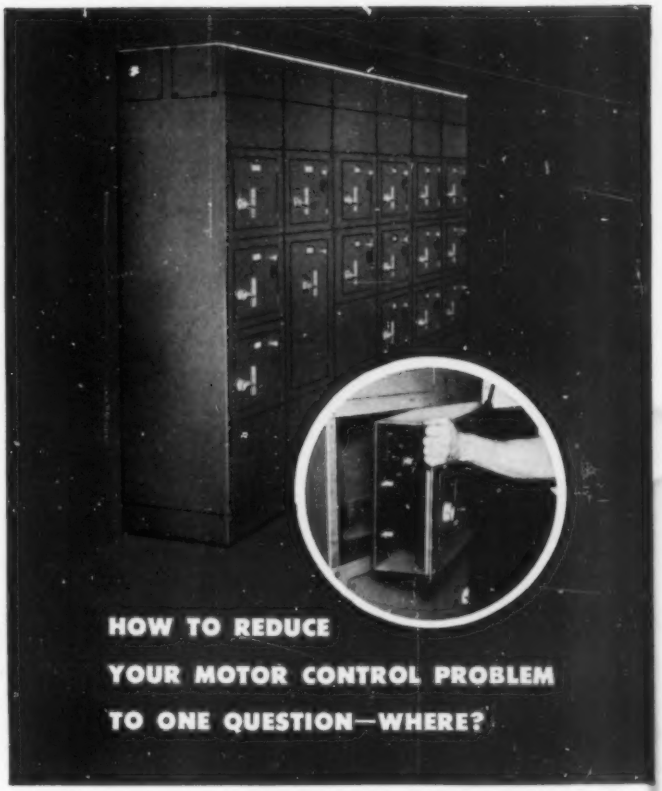
(50) STAINLESS STEEL TUBING —Babcock & Wilcox Tube Co. Bulletin TB-19, 4 pp. and Technical Data Card 140, 4 pp. First is a tabulation of the chemical, mechanical and other properties of 10 types of seamless and welded stainless tubes and pipe. The other is a more detailed discussion of three of these types and goes in the matters of their fabrication and applications as well.

(51) GRAPHIC TECHNIQUES—Technagraph Co. 2 Catalogs, 4 pp and 10 pp. Tells of the firm's facilities for making isometric renderings, exploded views, and other graphic displays to simplify transmittal of technical information. Examples of work are included.

(52) OIL BURNERS—Hauck Mfg. Co. Catalog 412, 2 pp. Gives sizes and dimensions for an oil burner used on horizontal rotary kilns.

(53) HYDRAULIC FLUID—Monsanto Chemical Co. Technical Bulletin O-D-602, 4 pp. Tabulates properties and test results of a non-flammable hydraulic fluid developed primarily for die casting machines, hydroelectric turbins and similar equipment.

(54) ROLLER CHAIN—Atlas Chain & Mfg. Co. Catalog ARC-51, 28 pp.



"Building-block" units permit grouping all motor controls at one point

You control *all* the motors in an entire area, floor or building—when you *centralize* the controls with Ward Leonard MULTITROL*.

Prefabricated MULTITROL units (each a complete control for one motor) fit into standard framework in any arrangement to suit the space. Units can be added, subtracted, interchanged, or relocated.

Some of the problems MULTITROL solves include: *Structural framework*—none needed, MULTITROL units are free-standing. *Obstructions*—no difficult cable or pipe forming, no chopping out walls. *Appearance*—no haphazard box mounting. *Safety*—completely deadfront construction.

Investigate MULTITROL. Wide choice of starter types, combined with externally-operated thermal circuit breakers. Write for Bulletin 4410. WARD LEONARD ELECTRIC CO., 63 South Street, Mount Vernon, N.Y. Offices in principal cities of U. S. and Canada.

*Also available for D-C

WARD LEONARD ELECTRIC COMPANY

Result-Engineered Controls Since 1892

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

GOT RECORDING PROBLEMS

FIG. 1

SANBORN

1, 2, and 4 channel RECORDING SYSTEMS

FIG. 2

FIG. 3

- NO INK
- DIRECT WRITING
- RECTANGULAR COORDINATES
- PERMANENT RECORDS

Electrical phenomena from a few millivolts to over 200 volts may be readily and continuously recorded. Registration, by heated stylus on *plastic*-coated paper, is clear, sharp, *permanent*. **Single-channel** Model 128 (Fig. 1) has standard speed of 25 mm./sec. (slower speeds available). **Two-channel** Model 60 (Fig. 3) has ten speeds — 0.5 to 100 mm./sec. **Four-channel** Model 67 (Fig. 2) has eight speeds — 0.25 to 50 mm./sec. Built-in timing and code marking, and ready interchangeability of Amplifiers (D.C. and Strain Gage) are features of all models.

For complete descriptions, illustrations, tables of constants, and prices, send for catalog, using coupon below.

SANBORN COMPANY

INDUSTRIAL DIVISION
39 Osborn St.,
Cambridge 39, Mass.

Please send me complete catalog of Sanborn Industrial Recording Equipment.

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New Catalogues .....continued

Begins with an illustrated discussion of the construction features of the firm's roller chain. Next in order, such matters as the determining of sizes, computing of lengths, chain drive layouts, horsepower ratings, and installation and maintenance are taken up. Dimension charts complete the catalog.

(55) STRAIN GAGES—Baldwin-Lima-Hamilton Corp. Bulletin 174, 2 pp. Charts help to describe a SR-4 temperature compensated strain gage for use on dura' or steel in temperature ranges up to 300 F.

(56) STRAINALYZER — Baldwin-Lima-Hamilton Corp. Bulletin 331, 2 pp. Brings out the characteristics, general uses, specifications and components of an instrument designed for dynamic strain and vibration studies.

(57) SMALL STAMPINGS—George K. Garrett Co., Inc. Catalog, 32 pp. Two color display of spring lockwashers, lockwashers, spring nuts, spring lock nuts, spring washers, finishing washers, flat washers and other small stampings. For each product the types available are shown and their dimensions are tabulated.

(58) HEAT TRANSFER EQUIPMENT—Fatterson-Kelly Co. Catalog, 4 pp. Illustrated index of the firm's heat exchangers, blenders, kettles, and other items of heat transfer and process equipment.

(59) MAGNETIC CONVEYOR UNITS—Eriez Mfg. Co. Bulletin 553, 4 pp. Drawings of typical installations explain a magnetic converyor element used in conveyors to handle the products of pipe roll mills, sheet and plate mills and others.

(60) OILER COMPONENTS—Eynon-Dakin Co. Catalog B-3, 8 pp. Composed of a group of illustrations of oilers, vents, caps, and tube forms. For each product is given a brief description, the models available and dimensions.

(61) TESTING MACHINES—Tinius Olsen Testing Machine Co. Bulletin 40, 8 pp. Points out the features of a hydraulic testing machine available with 3 ranges in capacities up to 400,000 lb. One of these features is a separate electronic indicating system. Drawings, photographs and charts illustrate the important considerations.

(62) COLD HEADED FASTENERS—John Hassall, Inc. Catalog 60, 34 pp. Separated into labeled, step down sections for quick reference, this catalog outlines the advantages derived from manufacturing fasteners by means of the cold heading method and then goes on to describe in detail a wide variety of nails, rivets, screws

10-DAY DELIVERY!

SIMPLEST... MOST COMPACT

O-M

AIR HYDRAULIC WATER CYLINDERS

Add up these advantages. They are the reasons why more and more equipment manufacturers are specifying Ortman-Miller cylinders for all types of applications.

Simplicity of design eliminates tie rods and bulky end caps . . . saves one-third in installation space. All parts and mounting brackets interchangeable bore for bore. Cost less to buy, install and service. Full range of sizes (1½" to 8" bores) *available for early shipment*. Machined steel (no castings) and bearing bronze throughout.

Write today for details! Speed production, cut costs and save space with Ortman-Miller cylinders.

FREE TEMPLATES

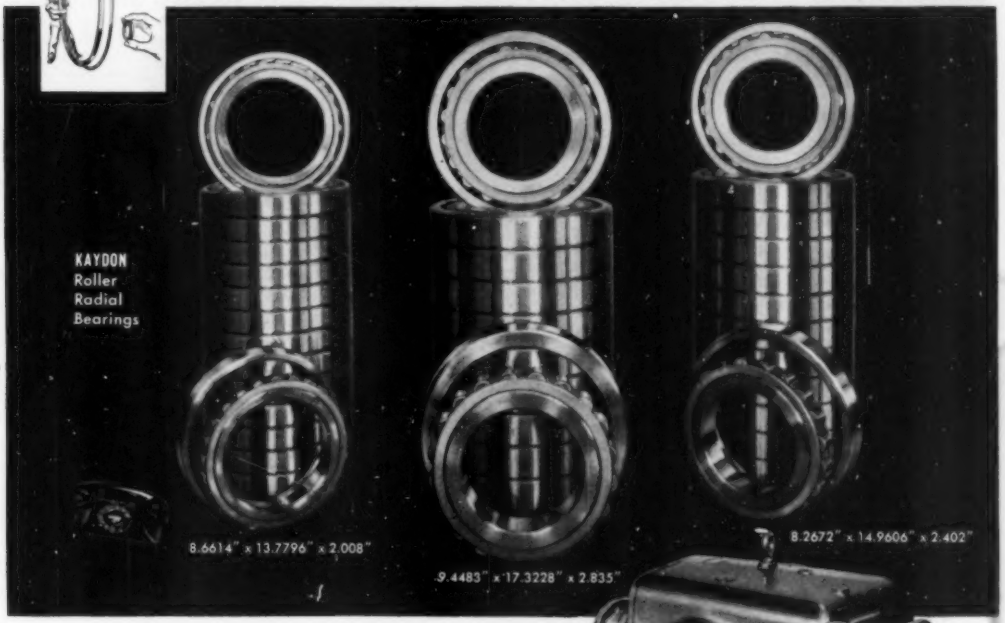
For the first time in the industry, O-M offers a complete set of templates showing all cylinders and mounting brackets. ½ scale. Your set on request.

ORTMAN-MILLER MACHINE CO., INC.

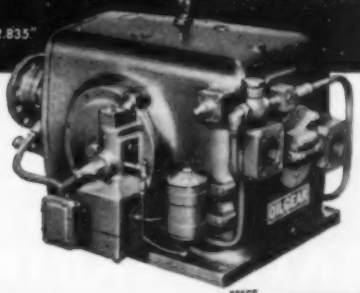
1218 150th Street Hammond, Indiana

Contact KAYDON Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



KAYDON and OILGEAR
cooperate for compact design



OILGEAR engineers, pioneering Fluid Power Pumps and Motors, achieved greater compactness and efficiency than ever before considered possible. KAYDON Engineers, pioneers in Thin-Section Precision Bearings, created bearings that were "right at home" at the high level of OILGEAR advanced design.

KAYDON Precision Bearings and Needle Rollers have helped many machinery builders achieve modern design with fewer parts, greater compactness, reduced weight, precision smoothness in operation . . . advantages that improve production, cut costs, and carry impressive sales appeal.

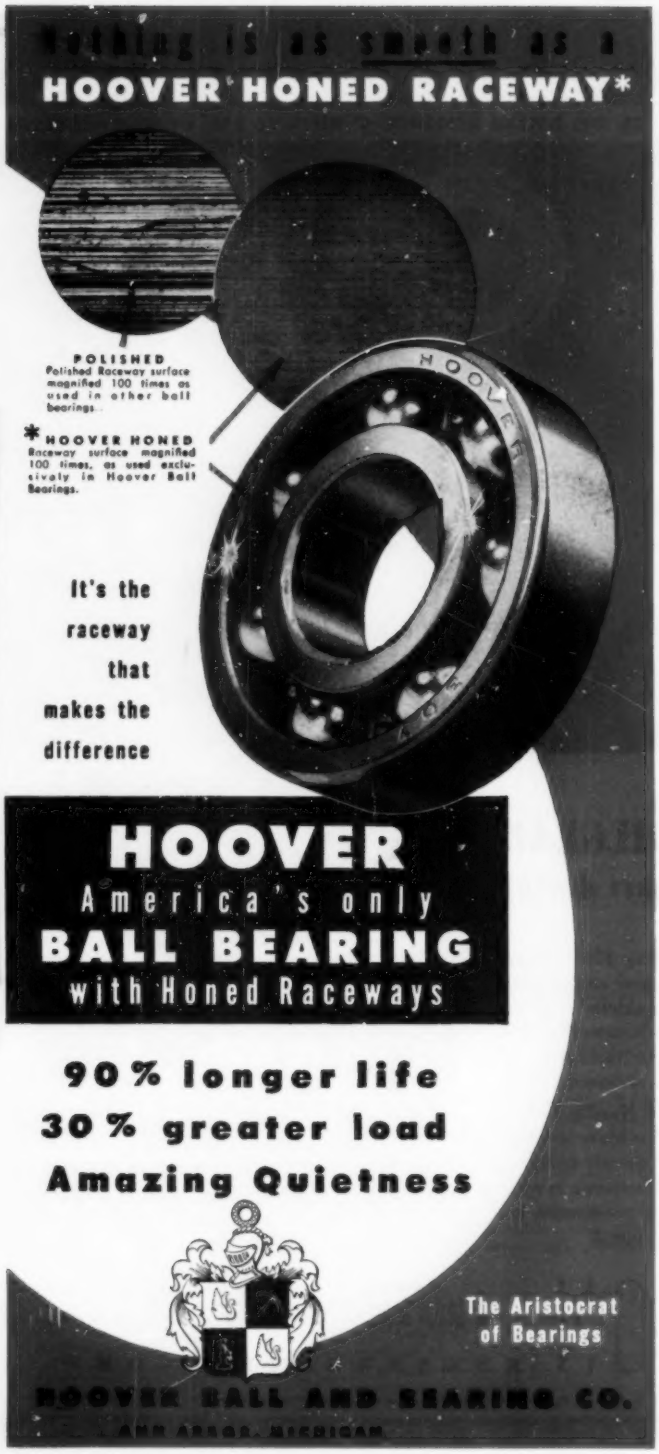
OILGEAR This exploded view shows KAYDON Front and Rear Roller Rotor Bearings with relation to other parts of the 150 hp OILGEAR Fluid Power Variable Delivery Pump (above) for machinery with operating-pressures up to 3000 pounds per square inch . . . with smooth, quiet, startlingly new fluid power performance characteristics. KAYDON Bearings are used also on 60 hp and 100 hp OILGEAR Fluid Power pumps.

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust
• Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS


Nothing is as smooth as a
HOOVER HONED RACEWAY*
POLISHED
Polished Raceway surface magnified 100 times as used in other ball bearings.
* HOOVER HONED
Raceway surface magnified 100 times, as used exclusively in Hoover Ball Bearings.
It's the raceway that makes the difference
HOOVER
America's only
BALL BEARING
with Honed Raceways
90% longer life
30% greater load
Amazing Quietness
The Aristocrat of Bearings
HOOVER BALL AND BEARING CO.
ANN ARBOR, MICHIGAN

New Catalogs.....continued

and other specialties. All are illustrated, and there are tables of dimensional data.

(63) CEMENT APPLICATION—Pennsylvania Salt Mfg. Co. Bulletin, 1 pp. Shows the step by step procedure in applying corrosion resistant cement over steel guidework.

(64) PINIONS AND GEARS—General Electric Co. Bulletin GEA-1054B, 8 pp. Pictorally describes pinions and gears designed for railroad, urban transport and industrial haulage equipment, the facilities for manufacturing and testing them and ordering information.

(65) PUMPS AND HEAT EXCHANGERS—Nukem Products Corp. Catalog, 4 pp. Photographs and graphs bring out the construction and operating characteristics of corrosion resistant pumps, heat exchangers and floor drains used in the liquid transfer of acids, salts, alkalis, and organic solvents.

(66) AIRCRAFT STEELS—Joseph T. Tyerson & Son, Inc. Booklet, 68 pp. Lists forms, sizes and weights in which each of a group of aircraft steels is stocked. The last half of the booklet gives in tabulated form the chemistry, condition, form and equivalent standard AISI specification for Military, Air Force, Navy, Federal and AMS aircraft quality steels.

(67) HYDRAULIC FLUIDS—Carbide and Carbon Chemicals Div., Union Carbide and Carbon Corp. Bulletin, 12 pp. Information from case histories helps to show the fire resistant qualities of a line of hydraulic fluids for die casting machines, steel mill furnace control regulators, and similar equipment. Viscosity graphs and other charts are included.

(68) RELAYS—Potter and Brumfield. Catalog 109, 24 pp. Illustrated presentation of several series of general purpose and special purpose relays. For each series is given a description of components and features as well as dimensional diagrams and charted information. Near the end of the catalog are shown other products such as shaded pole motors, synchronous timers, signals and special timers.

(69) PRESSURE-SENSITIVE TAPE—Minnesota Mining and Mfg. Co. Catalog, 6 pp. Lists government specifications for tapes and cites the firms corresponding tape.

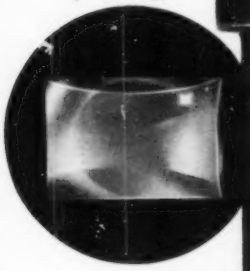
(70) VISCOSITY MEASUREMENT—Fischer & Porter Co. Catalog 88, 12 pp. A exposition making use of graphs of the firm's methods for continuous or instantaneous measurement of viscosity values in industrial processes is followed by a descriptiion

MICO-VUE, molded and assembled for Mico Photo Products, Chicago ▶

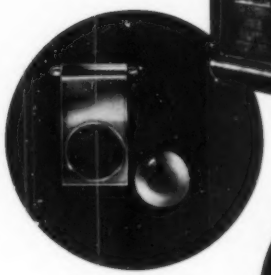
Inside side-section view, note insets

Outside side-sectional view, note design detailing

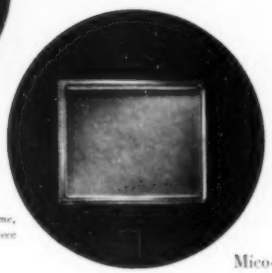
Fine optical glass lens, which, together with reflecting mirror, was included in our assembling job ▼



Baby picture, Santa Fe Photo



Plastic lens hinged mount for magnifying glass



Plastic diffuser and frame, molded in one piece

NEW VIEWER

New View on what Plastics Can Do

You can draw some profitable conclusions for your own plastic products from these views of Mr. "Mike" Wolk, president of Mico Photo Products.

Mr. Wolk said he wanted his viewer to be plastic not only because of the lower production cost, but for the greater attractiveness and color variety which he felt plastics afforded over other materials.

This, then, was a complete start-to-finish molding and assembling job for us. Everything that went into this new viewer except its fine precision optical lenses and metal slides was made of plastic.

Economy and strength were the factors in molding the Mico-Vué with a minimum number of castings. The light diffuser and frame were molded in one piece for greater economy and more attractive appearance. Even the lens hinge mounts were molded.

Although this viewer is new, the idea of doing a thorough engineering and molding job economically and beautifully is an old story with us.

We'd like to tell you that story and show you how we can serve you. Just let us know when we may. We'll do the rest.

Write on your letterhead for the new injection Molded and Extruded Plastics Catalog. Or, for detailed information about [illegible]* *piping, tubing and fittings, write for circulars containing data and illustrations.*

ELMER E. MILLS CORPORATION

INJECTION MOLDERS and EXTRUDERS of: Tenite, Lumarith, Plastacele, Ethocel, Lucite, Nylon, Plexiglas, Polystyrene, Styron, Loalin, Vinylite, Geon, Flexene, Polyethylene, Carex, Fortiflex, [illegible]*, Saran, and other Thermoplastic Materials.

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*Trademark Registered

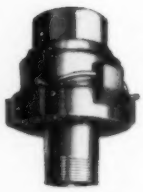
—when you need movable joints in piping

BARCO

Style 7-8

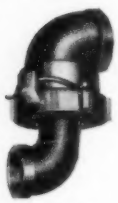
FLEXIBLE BALL JOINTS

Style 7-8B



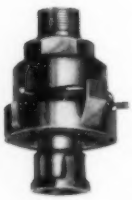
Style 7-8C

Style 7A-8

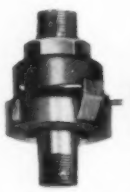


Style 7A-8B

Style 7A-8C



Style 7C-8



Style 7C-8C

Style 7F-8F

—many other styles available.

Versatile!

THE BARCO Flexible Ball Joint is one of the most useful, most versatile fittings ever developed for application on piping conveying steam, oil, gas, water, air, chemicals, refrigerants, or other fluids. Find out how these simple, rugged, economical joints can help you:

- **Provide for movement in piping—up to 40° side flexibility in any direction, plus 360° rotating movement!**
- **Protect piping against strain, stress, settling, shock, or vibration!**
- **Overcome piping misalignment!**
- **Provide insulation barriers to stop electrical currents causing electrolysis in piping. Also used to prevent leakage of current from plating tanks.**

FIRE-PROOF! PRESSURE SAFE! No side thrust developed by pressure in piping even if one end is suddenly loosened. No danger of whipping! Available in materials suitable for temperatures from -50° to as high as 1,000° F.; for pressures from vacuum to 750 p.s.i. steam, or 6,000 p.s.i. hydraulic.

COMPLETE LINE—15 different sizes, ¼" to 12". Angle or straight, male or female threaded connections—flanged connections—welding ends for welded connections. Choice of seven different gasket materials to meet various service requirements, including "TEFLON" gaskets with stainless steel bodies for handling corrosive liquids or gases. Also magnesium bodies for light weight in large sizes. In ordering, specify service. *Write for latest, illustrated literature.* BARCO MANUFACTURING CO., 1827 E Winnemac Ave., Chicago 40, Ill. In Canada: The Holden Co., Ltd., Montreal.

BARCO

THE ONLY TRULY COMPLETE LINE OF FLEXIBLE, SWIVEL, SWING AND REVOLVING JOINTS

Worldwide Sales and Service

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

of each of instruments for performing these tasks. Photographs show the instruments and their application and diagrams explain the flow pattern.

(71) BLOWER—Standard Stoker Co., Inc. Catalog, 6 pp. Tabulated data on dimensions and capacities of a number of blowers. Photographs of the blower and its applications are included.

(72) LININGS—Atlas Mineral Products Co. Bulletin 4–1, 4 pp. Outlines in chart form a number of corrosion proof linings for equipment for baths, foods, fermentation, detergents and others. For each lining material is given such data as temperature, cost and corrosion resistance properties.

(73) PILOTED TYPE COUPLINGS—Falk Corp. Bulletin 4115, 6 pp. A cutaway view brings out the construction features and diagrams show the action of a flexible coupling that supports a long shaft extension or floating shaft.

(74) SPECTROGRAPHIC ANALYSIS—Baird Associates, Inc. Bulletin 35, 4 pp. Bulletin 32, 12 pp. The first describes a source unit that employs a-c spark, a-c arc and d-c arc circuits for exciting samples for emission spectrography. The second covers the subject of spectrography, discusses the advantages and characteristics of grating spectrographs and then describes the manuacturer's spectrograph. Illustrated.

(75) WELDING FITTINGS—Taylor Forge & Pipe Works. Chart. Gives dimensional data for welded fittings and forged steel flanges.

(76) MILL MOTORS—Westinghouse Electric Corp. Booklet, 20 pp. Illustrated explanation of the construction of a series of d-c mill motors. Second half of catalog is devoted to bringing out the advantages of the magnetic controllers for use with the motors.

(77) HOSE—New York Belting & Packing Co. Catalog, 16 pp. Contains engineering data, construction specifications and other information to aid in the selection and care of fire hose, dust conveying hose, creamery hose and lacquer spray and solvent hose.

(78) DIE CASTINGS—Hoover Co. Booklet, 12 pp. After some general remarks on the materials used in die casting and their finishes, the discussion goes on to show photographically how die castings are made. Included are hints for designing good die castings and a chart listing physical and chemical specifications for two alloys, aluminum and zinc.

(79) ROLL FORMED SHAPES—Roll Formed Products Co. Catalog, 8 pp. Shows the facilities for producing

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tees, tubes, angles, channels and other sections from stainless or carbon steels, zinc, brass, copper and aluminum.

(80) GRAY IRON CASTINGS—Gray Iron Founders' Society. Folder, 4 pp. Describes the position this industry has among other metal working industries. Illustrated.

(81) LAMINATED PLASTICS—Taylor Fibre Co. Catalog, 62 pp. The first of the four sections deals with vulcanized fibres. For each of the grades is given a description, applications, forms and sizes available and properties. The second section on phenol fibre and special laminates is treated in similar fashion. The third section outlines design and fabricating procedures in the use of these materials and the fourth displays the firm's manufacturing facilities.

(82) OIL PURIFIERS—Honan-Crane Corp. Bulletin, 4 pp. Illustrated presentation of oil purifiers used in hydraulic systems to remove contaminants.

(83) DRILL JIGS—Siewek Tool Co. Template Sheets. These sheets, covering rack and pinion and spring type drill jigs, are said to expedite drafting in machine and tool design.

(84) MAGNETIC SEPARATORS—Eriez Mfg. Co. Bulletin 702, 4 pp. Describes a magnetic unit designed to remove tramp iron from materials conveyed in pneumatic, gravity flow or liquid lines. Included are dimensional data.

(85) MICRO BELLOWS PUMP—Research Appliance Co. Booklet, 12 pp. Covers construction, operation, capacity, electrical requirements, maintenance and application of this stainless steel metering pump. Diagrams disclose its operation and exploded views shows its parts.

(86) STEEL PARTS—Henry Disston & Sons, Inc. Booklet, 16 pp. Outlines the facilities of this firm to supply custom made, flat steel parts. Pictured and described are a number of products which have unusual requirements.

(87) COLD FINISHED STEELS—Wyckoff Steel Co. Chart. Lists weights for steel rounds in diameters up to 6 in. and lengths up to 24 ft.

(88) DIRECT WRITING RECORDERS—Sanborn Co. Catalog, 6 pp. Contains information on a group of direct writing recorders and instrument amplifiers.

(89) AIR MOTORS—Bellows Co. Bulletin CL-30, 24 pp. Contains a factual presentation of means by which operations can be speeded and

cost reduced through the use of air motor power. In the center of the bulletin, a two page spread in color of the air motor displays its design features. Machines using the air motor for motive power-drill press feeds, arbor presses and others—are also made by this company. These, too, are pictured and described.

(90) FLOATING DISK CLUTCH—Carlyle Johnson Machine Co. Booklet, 16 pp. Made up principally of 16 case histories of machines in which the firm's clutch is used. However, one section is given over to an illustrated presentation of the design of the product

(91) PROPORTIONING EQUIPMENT—Richardson Scale Co. Bulletin 0550, 4 pp. Displays some control panels for maintaining constant product quality through proper proportioning and blending of ingredients.

(92) ASTE EXPOSITION — American Society of Tool Engineers. Booklet, 8 pp. Statistical analysis of the show visitors' attitudes and motivations.

(93) ELECTRICAL TAPES—Bishop Manufacturing Co. Catalog, 4 pp. Points out the advantages, applications and electrical, physical and chemical properties. Included is a sample of the tape.

(94) WASHERS AND SEALS—Design Aids Co. Bulletin, 6 pp. An outline drawing, a table of dimensions and a brief description present the characteristics of the firm's expansion plugs, clamping washers and felt seals.

(95) AIRCRAFT HOSE—Resistoflex Corp. Catalog, 12 pp. The first half is devoted to showing various types of hose and the sizes, dimensions and pressures in which they are available. Next comes a display of hose fittings for which are tabulated sizes, dimensions and weights. Graphically portrayed are flow data for these fittings and hose bend radii at various pressures.

(96) ALUMINUM COATING—American Chemical Paint Co. Folder, 4 pp. A comparison between the firm's corrosion resistant coating for aluminum and those using other protective methods. Its method of application is described.

(97) AIR COMPRESSOR DRIVES—Electric Machinery Mfg. Co. Catalog, 24 pp. Begins with an illustrated discussion of the glass industry and its products to show the part air compressors and their drives play in this field. Next is explained the type of motor needed to drive compressors, namely, the synchronous motor. The remainder of the catalog describes

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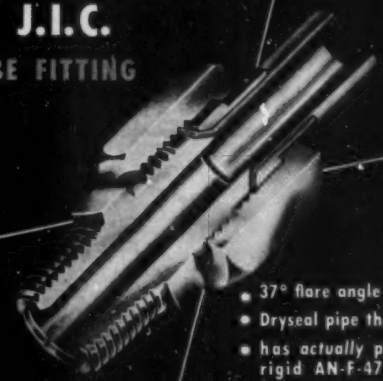

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the operation, construction and similar aspects of these motors and their auxilliary units.

(98) SPEED REDUCERS — Dodge Manufacturing Corp. Describes and provides selection tables and other data for a line of torque arm speed reducers which mount directly on the driven shafts and are locked to them at both sides of the reducers. Output speeds range from 115 to 330 rpm and capacities to 27 hp.

(99) FLEXIBLE COUPLINGS — American Flexible Coupling Co. Catalog 501, 12 pp. Gives information about both the gear type coupling and the Oldham type coupling produced by this firm. The design of the gear type has been recently modified to increase load capacity and reduce backlash. Rating tables, dimensional data, and illustrations aid the description.

(100) ELECTRONICS SUPPLIES — Sun Radio & Electronics Co., Inc. Catalog 51, 132 pp. A supplier's catalog of the radio and electronic products of many companies. Included are such groups as instruments, components, radio hardware and tools. In general, each product is illustrated and described briefly. In many cases rating tables, dimensional data and similar information are given.

(101) DIELECTRIC CONSTANT— Eberback & Son Co. Bulletin 280, 1 pp. Describes a meter for measuring the dielectric constant of liquids and for demonstrating the principles related to this property.

(102) CENTRIFUGAL DIE CASTINGS—Lebanon Steel Foundry. Catalog, 12 pp. The advantages and methods now employed of producing symmetrical shapes by centrifugal casting are pointed out and then the discussion goes on to describe the new development of applying metal molds to this casting process. Some typical cross sections produced are shown.

(103) PRECIPITATING SOFTENER —Worthington Pump and Machinery Corp. Bulletin W-212-B6, 6 pp. A flow diagram as well as photographs help to describe a precipitating softener and coagulator in which energy for flow preparation is mechanical.

(104) TRANSFORMERS AND RECLOSERS—Line Material Co. Bulletin DT7, 4 pp, Bulletin CR1A, 8 pp. Index to General Catalog, 24 pp. The first contains photographs of and gives dimensions for a line of dry types, single phase distribution transformers, 1½ through 50 kva. The second presents information concerning an oil circuit recloser with 3,000 to 6,000 amp maximum interrupting capacity. Included are illustrations

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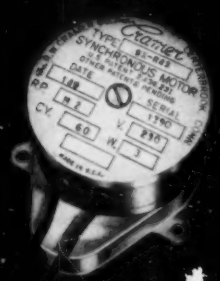

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showing construction features and a chart of time-current characteristics.

(105) PAINT INTERMEDIATE — Diamond Alkali Co. Bulletin, 15 pp. Describes a chemically inert, non-toxic chlorinated paraffin resin used as a paint intermediate. Tabulated data shows the effects of adding certain percentages of it to 12 white, green and red vehicles.

(106) FERROUS CASTINGS—Belle City Malleable Iron Co. Folder 10, 4 pp. Charts the structure, physical characteristics, applications and advantages of a group of metals.

(107) STAINLESS TUBE BENDING—Carpenter Steel Co. Slide chart. Presents data on desirable minimum radii for economical bending of stainless tubing and pipe. Also contains tables of standard sizes of tubing, theoretical bursting pressures and physical properties.

(108) SALT BATH BRAZING—Ajax Electric Co., Inc. Bulletin 124, 4 pp. Describes the salt bath brazing process and shows examples of the product thus produced.

(109) VACUUM COATING UNITS—Eastman Kodak Co. Data Sheet, 4 pp. Describes in chart form the construction, capabilities, and performance of all vacuum coating units produced by equipment of this type.

(110) DIESEL ENGINES—General Motors Corp. Catalog, 36 pp. Replete with photographs, cutaway views, diagrams and specification charts, this catalog covers the complete line of a 2 cycle series of diesel engines for application in the industrial, petroleum and marine fields. Engines are available in single or multiple units from 2 to 24 cylinders with power ranging from 32 continuous to 780 intermittent horsepower.

(111) TEMPERATURE CONTROL—Leeds & Northrup Co. Folder, 8 pp. Describes temperature controls for glass feeders. Sketches show the location and installation of primary elements in the feeder and a schematic diagram relates units of the control system to the detection and control sequency.

(112) FINTUBES—Brown Fintube Co. Bulletin 511, 8 pp. Describes the construction, lists the range of sizes and materials and illustrates the applications of integral extended surface fintubes. Included are three pages of engineering data and charts concerning these units.

(113) STAMPED WIRED CIRCUITS—A. W. Franklin Mfg. Corp. Booklet, 16 pp. Describes the process of die stamping electrical and electronic circuits and parts. Many illustrations of examples are included.

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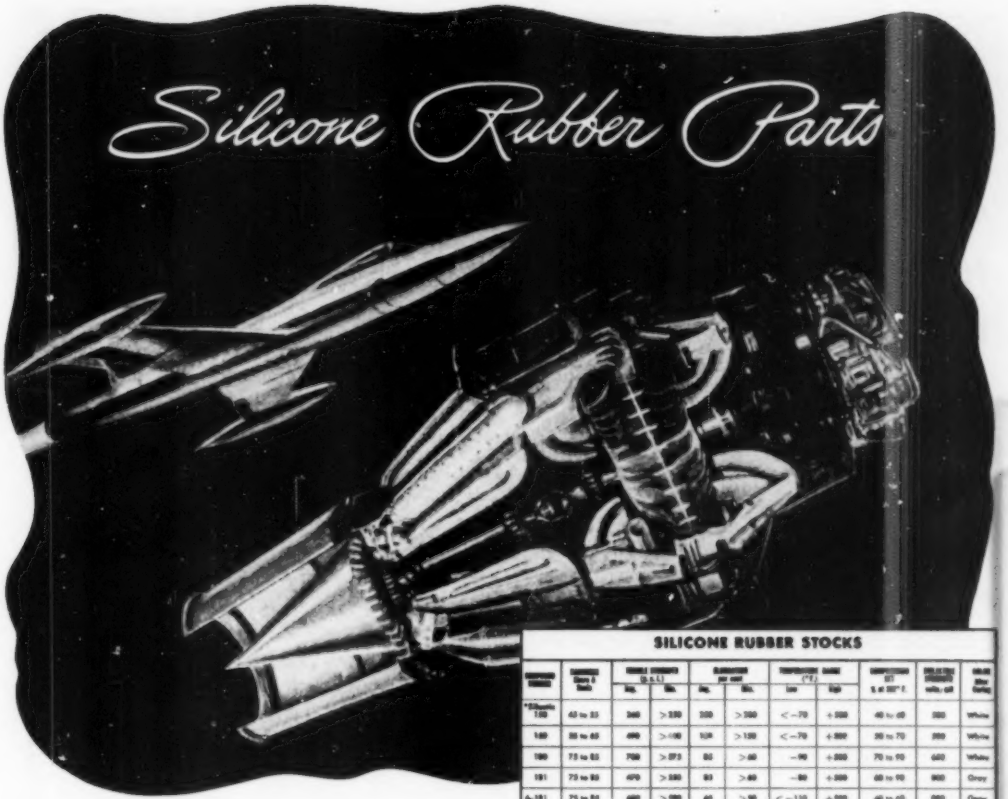

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190	75 to 85	700	>875	80	>60	−90	+500	70 to 90	600	White
191	75 to 85	470	>550	85	>60	−80	+500	60 to 90	900	Grey
6-181	75 to 85	600	>700	60	>90	<−110	+500	40 to 60	800	Grey
350	40 to 55	650	>850	300	>350	<−110	+500	40 to 60	900	Orange-tan
**G-E 81223	40±5		900		450	−85	+500	60 to 75	480	†
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†General Electric silicone rubber can be tinted in a choice of colors.

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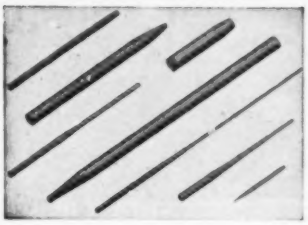

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ACOUSTICAL SOCIETY OF AMERICA—Annual Meeting, Wardman Park Hotel, Washington, D. C.

May 16-18

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS—Wardman Park Hotel, Washington, D. C.

May 22-25

NATIONAL CONFERENCE ON WEIGHTS AND MEASURES—Wardman Park Hotel, Washington, D. C.

May 23-24

AMERICAN SOCIETY FOR QUALITY CONTROL—Fifth Annual Convention, Hotel Cleveland, Cleveland, Ohio.

May 24-25

SOCIETY OF THE PLASTIC INDUSTRY—Annual National Meeting, Greenbrier Hotel, White Sulphur Springs, W. Va.

May 30-Sept. 9

WORLD TRANSPORTATION FAIR—Santa Anita Park, Arcadia, Calif.

June 3-8

SOCIETY OF AUTOMOTIVE ENGINEERS—Summer Meeting, French Lick Springs Hotel, French Lick, Ind.

June 4-6

AMERICAN GEAR MANUFACTURERS ASSOCIATION—35th Annual Meeting, The Homestead, Hot Springs, Va.

June 11-15

SECOND ANNUAL CONFERENCE ON INDUSTRIAL RESEARCH—Conducted by Columbia University Dept. of Industrial Engineering, New York

June 11-15

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Semi-Annual Meeting, Hotel Royal York, Toronto, Ont., Can.

June 11-16

NATIONAL CONGRESS OF APPLIED MECHANICS—Sponsored by Illinois Institute of Technology, Chicago, Ill.

June 18-22

AMERICAN SOCIETY FOR TESTING MATERIALS—54th Annual Meeting, Chalfonte-Haddon Hall, Atlantic City.

June 21-22

MALLEABLE FOUNDERS' SOCIETY—Annual Meeting, The Homestead, Hot Springs, Va.

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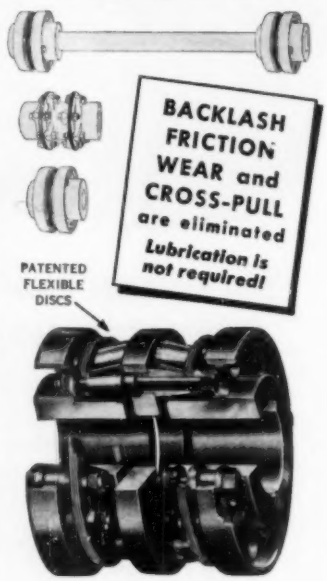

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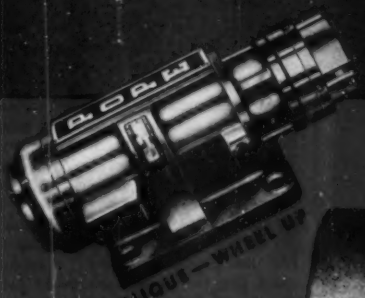

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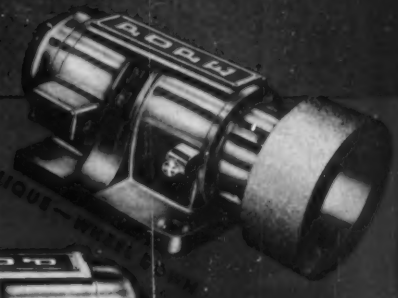

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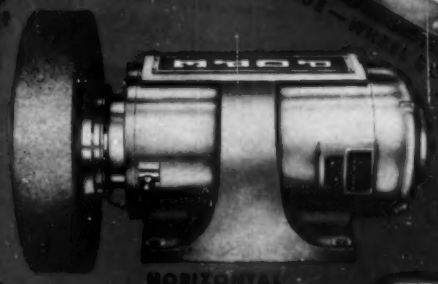

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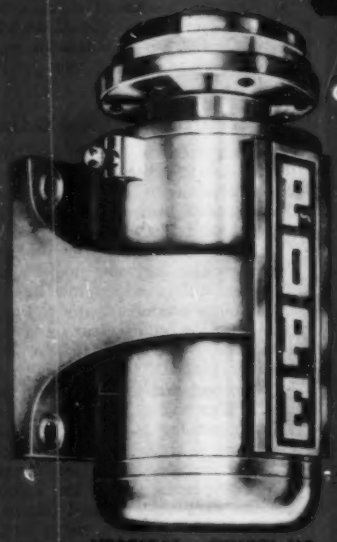

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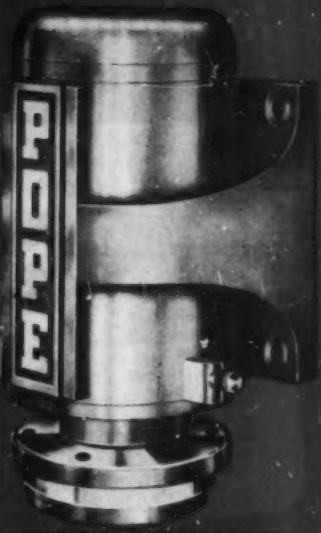

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NOTEBOOK
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A Marman V-Band Coupling attaches the bell end to the hydraulic reservoir of the high performing U.S. Air Force's Northrop Scorpion F-89. Providing a highly efficient and easily assembled seal, the Coupling serves also to attach reservoir to structure by means of two extra trunnions, illustrating the versatility of this standard unit.
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Sans, Souci

Ad Libbing by the Editor

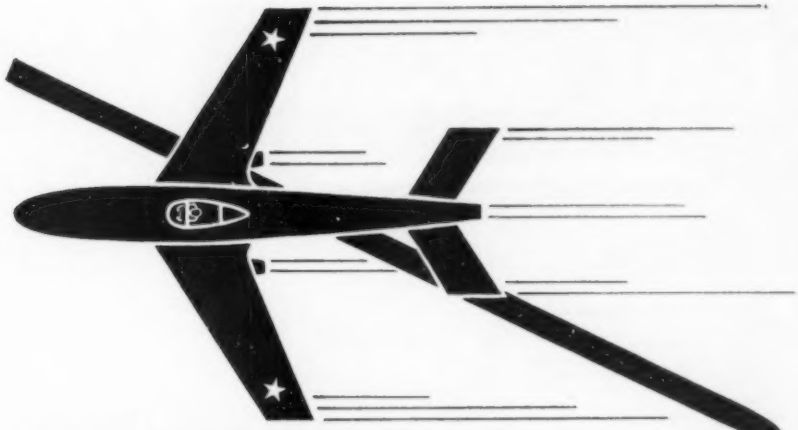
It was not surprising that we received quite a number of letters complaining that the title of this column is not pronouncible. Admittedly, the words are foreign, especially to an Irishman who has never studied French. But I must protest that Souci, meaning "trouble", is not pronounced "sousey", though to some the column might have that flavor. Just to keep the record straight, Souci is pronounced like "soo-see". And of course, Sans, meaning "without" is pronounced like "sahn", the two middle letters being pronounced exactly like the expression "ah!" I understand that the Frenchmen never pronounce the "s" at the end of a word, but not being a Frenchman I am not so sure about it.

Of course as can be expected, we did get some gripe letters about this new column. And those kind of letters are the most constructive. In fact only recently, a research foundation in Chicago announced a discovery that the men in an organization who gripe are also the men who are most progressive and who are most prolific in developing new ideas.

Deadheads, Bellyachers and K' ers

Which reminds me of my boss, F. V. Larkin when he was general superintendent of Harrisburg Steel. He classified men as kickers, bellyachers and deadheads. As he put it, "Deadheads are worth nothing to anybody, because they are simply dead and dead things don't grow nor do dead things produce anything. Bellyachers are the fellows who are always complaining about things that cannot be changed. They are the ones who demand that the sun should rise in the West and set in the East. And because nothing that they complain about can be changed, the bellyachers are just nuisances who are forever blocking progress. But the kickers are the ones who demand improvements, higher efficiency, better working conditions and of course if they are ignored they will also kick for more money and they are usually worth it and get it."

When we stop to figure it out, if everybody in an organization is in perfect harmony and agreement with the status quo, there cannot possibly be any progress. It is only when one or more of the group disagrees and



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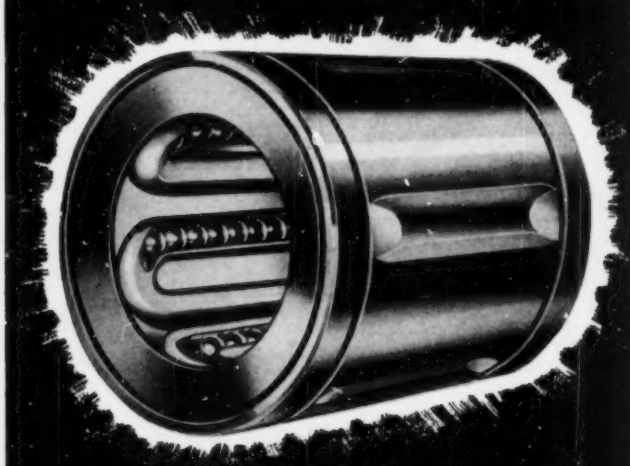

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expresses dissatisfaction with things as they are and puts forth every effort to change the conditions, that we get progress.

Sad to relate, only too often the man who does not agree with anyone else is considered to be the fellow who is out of step, the griper, the nonconformist. His assistants have a tendency to scorn him, belittle him and even sneer at him. However this is only natural because the level of human conceit is such that most individuals hate to be shown. And they often take the attitude, "If the idea were any good I'd have thought of it myself".

We Thrive On Trouble Makers

When you come to think of it, we must admit that the fellow who discovers something new, who invents a new machine, who develops a new process, who uncovers new facts of science or is a pioneer in any other respect is of necessity a terrible trouble maker. Just consider all of the trouble created by the invention and production of carbide tools. These simple little things finally obsoleted all existing machine tools, required new materials' handling methods to be developed, required shops to be laid out all over again and machinery completely rearranged. In fact, carbide tools completely revolutionized production thinking. And we can blame the whole thing on the man who developed the idea of carbide cutting tools. I wonder what his name was? He sure was a trouble maker and he must have had a tough job getting acceptance of his ideas. But all this simply goes to show that we should love the trouble maker, if he is the right kind.

In quite a few of our companies, the big ones and the progressive ones, the man in charge of engineering design bears the title of vice president and he participates in the conferences at the top level. It is significant that that is the situation in not only large companies but also small companies in which the engineering design plays a predominant part in the commercial success or failure of a product. This is highly significant because the trends in engineering and technology are such that more and more engineering is required of the product and the quality and complexity of the engineering is getting greater and greater. That is forcing better recognition for good designers. Engineering mistakes are getting easier to make and more costly. Many of us know that there are some companies that refuse to recognize this fact. They have been

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going along in the same old rut year in and year out and they have convinced themselves that they don't need high grade engineering and they are not much concerned about the standing and quality of the engineers in their organization. They resort to high pressure selling instead. Such situations are rapidly vanishing for the simple reason that the companies that do not value engineering design soon find themselves at a competitive disadvantage because of the lower quality of their product.

Simplicity Bespeaks Ingenuity

It was in one of those stick in the mud companies that one of my close friends, a design engineer par excellence, faced the problem of developing a safety device that was essential to the proper operation of the machine. This fellow did a whale of a job. He developed a highly ingenious original design, the like of which had never been seen before. The machine was built and the safety device was tested. It worked like a charm. All the top brass was out to see the test. Someone remarked to the president, "That certainly is a beautiful design, it works perfectly and is simplicity itself. The fellow who designed that deserves a big hand." To which the stuffed shirt president replied, "What do you mean he should have a big hand? How else could he design it? If he had designed it any other way it wouldn't work. That being the only way it could be designed, why should he have a big hand?" My engineer friend left the job shortly afterwards.

How Boss Kett Did It

Which reminds me of a story that Boss Kettering told me way back in the early thirties. G.M. was trying to develop a diesel engine for locomotive service. They got stumped in trying to design a fuel injection pump that was much better than any design available. And Kettering insisted it had to be a whale of a lot better. But every design that the research boys came up with was "the same old thing with only a different suit of clothes". Finally Kettering asked for a young man who knew nothing about fuel injection pumps, and got him in the office.

"I want you to find out exactly what a fuel injection pump is supposed to do. But you are not even to look at an existing design," Kettering told him. "We'll give you the machinists to make models. When you get the pump that you think is perfect, bring it in to me. Until then you get no

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other orders and I don't care if I don't see you for a year."

In a matter of three months the fellow delivered to Kettering what was at that time a radically new design and a very superior fuel injection pump. And it did the trick beautifully. Which is one more reason why most diesel electric locomotives have the General Motors label.

All this reminds me of the remarks of a president of one of our shipbuilding companies. The remarks were off the record so I cannot give you his name. However, the gist of it was that the engineering profession is not getting the credit to which it is due. In view of the fact that these remarks came from the president of a company and he is not a trained engineer, is highly indicative. And it just happens that right now we are in a position wherein engineers have a brilliant opportunity to raise their professional standing for the simple reason that they are in short supply, and for the reasons as given above.

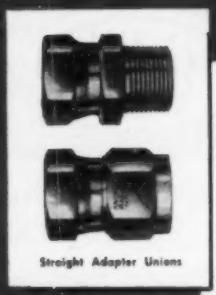
The Old Masters' Program

We all know that one of the problems confronting us today is the proper education and training of engineers. That is where the standing of the profession begins. Therefore I was very much interested when I received from my good friend, Colonel Chevalier, a copy of a letter he had received from Lawrence W. Wallace, management consultant of Cincinnati, Ohio.

Mr. Wallace points out that in the United States there are many experienced, wise and delightful men and women who are now retired or who soon will be. These people have a tremendous fund of excellent experience. Their judgment has matured over the years. They possess poise, culture and leadership. Mr. Wallace is referring to men, who in their careers have held positions of highest responsibility and authority and who are esteemed by their associates. These men he calls, "The Old Masters".

On the other hand there are large numbers of young men and women recently graduated, or about to be graduated from college, who could profit immensely from the kind of counseling that old masters might give them. Thereby the richness of experience, character, poise and culture of old masters might be imparted to young men and women who are just beginning their career.

Such an old masters' program was in fact conducted at Purdue University. The student counsel was in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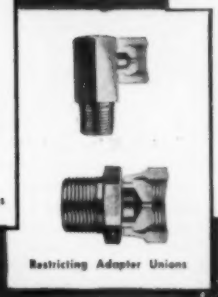
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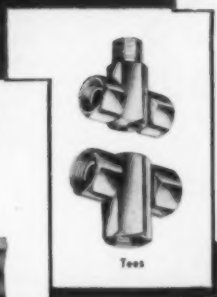
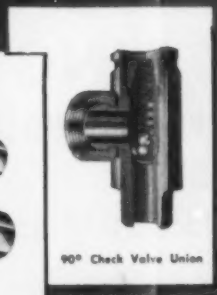

Tees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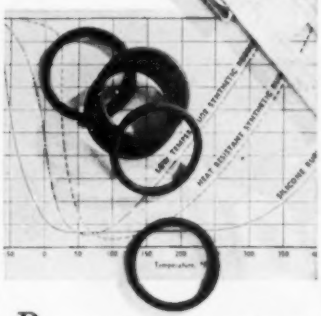

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charge of the program. Ten old masters, eight men and two women, were selected and they spent five days on the campus of Purdue, during which time they met small groups of three to five students. They gave no talks; they simply answered questions which the students wished to ask. According to the news write-up and editorials which appeared in the Purdue Exponent, the student publication, the program was a huge success.

Unquestionably, Mr. Wallace has an excellent idea. The years of college are the most formative ones for the young man. It is a time when he is most receptive to new ideas and the counseling of men who have made their mark and achieved positions of high responsibility and prestige.

Right along the same lines, it was Ben Graves, vice president in charge of engineering of the Brown and Sharpe Manufacturing Company who proposed and put into effect the student talks program, sponsored by the Machine Design Division of the American Society of Mechanical Engineers. Under Ben Graves' leadership, a number of speakers were selected who volunteered to speak to student bodies on the opportunities offered in engineering design as a carer. These talks given at dozens of colleges and universities over the past three years, have provoked tremendous interest and many students have expressed their appreciation.

Now for some Souci that I had since my last letter. We sent out several thousand copies of a questionnaire to our readers and got back almost five hundred replies. Now I personally appreciate it very much when a reader takes the time out to give me his honest thoughts and opinions concerning the job that PRODUCT ENGINEERING is doing editorially. The least I can do is to send a personal letter to each of these readers. So I began that job. I got a hold of a Gray Audograph and dictated one hundred odd letters and sent them to be transcribed. Unfortunately, two factors were involved. One was that I was not an expert at using the Audograph, and the other factor was that they were not expert in transcribing them. In other words, we didn't do the job right, simple though it be. To make a long story short, I have to begin all over again. And I am doing it again on the Gray Audograph because now that I know how to use, it does a swell job. So if you sent in one of those questionnaires you can bank on it that before the month is over, you will receive from me a personal letter.

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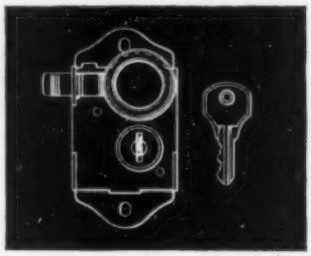

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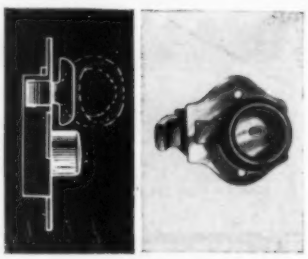

(left) Profile illustration of lock above shows how ring pull is pulled out to operate bolt. At right is a Flush Panel Board Catch, for use where no lock is required.

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ENGINEERING

ABSTRACTS

Barrel Finishing of Small Parts

Foreign Abstract from "More Productive Finishing by Barrelling" by Alan Whittaker. Mechanical World (London), February 9, 1951, pp 119 to 122.

OF INTEREST TO DESIGNERS of small parts are the data presented in this article regarding what types of parts can be tumbled and what is accomplished thereby. Unfortunately, the development and application of these processes has not been afforded the attention directed toward other metal finishing processes, with the consequence that the quality of barrelled finishes has generally been poor. As with other processes, careful control of the variables involved must be exercised if quality is to be maintained. A wide range of articles can be processed, but their size and shape impose limitations. On these factors depends the tumbling action during barrelling which in turn influences the surface finish. All kinds of fabrications, wrought or cast, may be barrel polished, subject to certain conditions. It should be pointed out, however, that a greater risk exists when castings are polished due to the usual intricacy of form characteristic of castings, and the variation of section thickness usually involved. Articles with any dimensions greater than 6 in. or weighing above 2 lb. are not generally suitable, but of course may be treated by any other methods.

Characteristics of the material from which the component is fabricated influence the technique of barrel finishing. Softer alloys of the zinc-base types are obviously subjected to greater damage risk during tumbling than steel or the harder bronzes. Modification of conditions enables most commercial alloys to be barrel finished.

Surface Action

The kinds of surface action produced during barrel polishing may be classified under the following headings:

1. Scouring
2. Cutting down
3. Burnishing
4. Polishing

While the techniques for effecting the above operations are determined

by the material being processed, the general purpose is similar in all cases. With some materials and certain surface conditions, some of the stages may be eliminated.

Scouring

This is used to remove heavy scale and more pronounced surface defects. Coarse abrasives, i.e., tripoli (SiO) and coke, and pumice or rotten-stone for brass and copper alloys and aluminum, used dry or with liquid additions, are employed.

Cutting down

Metal shapes are added to the load with or without abrasives. The shapes are generally stars or non-symmetrical pieces of steel or cast iron. The operation removes appreciable metal. Severity of cutting action is varied by adjustment of the size of the load. Smaller loads produce more intensive surface action.

Burnishing

As the name implies, this operation produces a high finish on suitable articles. The action is provided by alloy steel balls with soap and water added as a lubricant. The balls need not be perfectly round, shape not being important, providing that they are perfectly smooth. Various sizes of ball are available. Heavy shot will damage small articles. It is common practice to use mixed sizes to ensure that all areas of the component receive burnishing action.

Polishing

Brilliant finishes are produced on electro-deposits using mild abrasives, e.g. dry sawdust. These final finishing processes are utilized to facilitate stain removal. Hardwood, free from pitch, must be used.

The bulk of the article is devoted to discussions of the equipment, the abrasives and solutions used in tumbling and specific processing date.

Heat Treatment Improves Brittle Lacquer Accuracy

Foreign abstract from paper by Mr. K. C. Rockey presented before the Institute of Marine Engineers on January 9, 1951. Mechanical World (London), February 16, 1951, pp. 145-147.

MANY INVESTIGATORS have used the brittle lacquer method of stress analysis successfully and improvements in both technique and materials have been made from time to time. Tests made by the author indicate further

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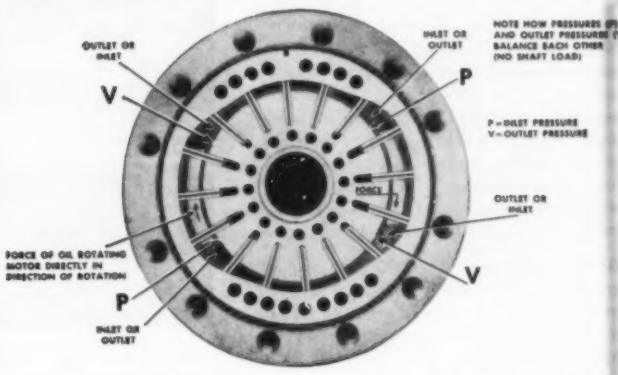
Will save YOU . . . Money, Space, Time!

Dudco Vane-Type Motors operate by direct force of the fluid against the vanes. The fluid enters through ports which are diametrically opposed, to balance shaft loads, and discharges in the same manner. Notes included with the figure below relate to fluid motor construction. Pump operation is similar, with the dual vanes bearing radially outward with positive forces which, while adequate for pressure sealing, are balanced hydraulically to eliminate undesirable wear producing thrust against the ring.



CHECK THESE FEATURES

- **DUDCO MOTORS operate down as low as 10 or 15 RPM at high torques often eliminating the necessity for gear reduction units**
- **Starting torque is over 95% of theoretical torque**
- **Torque ratings from 9 lb.-in. to 550 lb.-in. per 100 PSI available**
- **Quiet operating even at 3600 RPM**
- **Smaller size for ease of application**
- **Overall mechanical efficiency 85% at 1200 RPM, 77% at 100 RPM after long use**
- **120 HP available at 800 RPM**
- **Hydraulically balanced for long life—without any mechanical means for holding vanes out against the stator ring**
- **Rugged reversible service is common application**

CHECK THESE USES

- **Lumber (Resaws, slitters, conveyors, carriage feed works).**
- **Cannery (Box dumpers, fruit conveyors).**
- **Machine Tools (Thread tapping, lapping, indexing, bending machines, etc.).**
- **Chemical (Centrifuge, mixers, agitators, screw conveyors).**
- **Mining Equipment (Traction, Shoveling).**
- **Trucks (Hose reeling, conveyors).**
- **Railroad Work Equipment.**
- **Drilling Rigs (Rotary table, cathead winch)**
- **And many more**

DUDCO'S over 100 field representatives stand ready to assist in the application of Vane-Type Motors and Pumps to your equipment.

Write today for our complete catalog and our handy fluid motor data sheets showing HP output and speed vs. volume and pressure required.

Dudco PRODUCTS COMPANY

1784 E. Nine Mile Road * Hazel Park, Mich.

Please send me catalog and motor data sheets:

Name ..... **Title**.....

Company.. .....

Address .....

City ..... **Zone**..... **State**.....

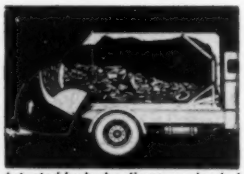
HYDRECO oil-hydraulic equipment provides "muscle power" in the Sicard "Sanivan" manufactured by Sicard Industries, Incorporated, of Watertown, New York, and Montreal, Canada. This most efficient, economical and versatile modern refuse collector is completely equipped with HYDRECO oil-hydraulic valves, pumps and cylinders. The complete hydraulic operation of compacting, loading and unloading are controlled at will by the operator. HYDRECO equipment is helping to clean up a dirty job.

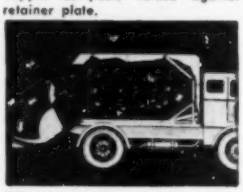
GEAR PUMPS — HYDRECO gear pumps are made in five basic sizes with a variety of flange or base mounted types, ½ GPM to 130 GPM, and for operating pressures up to 1500 p.s.i.

CONTROL VALVES—HYDRECO control valves are made in a variety of sizes and plunger arrangements, in capacities from ½ GPM to 150 GPM, and for operating pressures up to 1500 p.s.i.

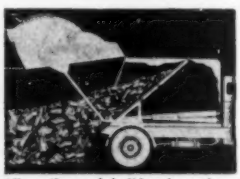
CYLINDER ASSEMBLIES — HYDRECO cylinders are made in single-acting, double-acting and telescopic designs in sizes up to 8" effective diameter. Plain, eye-type, or ends of special design are available for all sizes.

BUILD MORE PROFITABLE LABOR-SAVING INTO YOUR EQUIPMENT WITH *HYDRECO* CONTROLS


Actuated by hydraulic power, loaded hopper compacts refuse against retainer plate.


When loaded, retainer plate comes down flush against compressor plate.

HYDRECO cylinder operates unfolding bulkhead built in three sections.


All sections of bulkhead reach an angle of 45° with tailgate completely raised—assuring rapid, complete unloading.

HYDRAULIC EQUIPMENT COMPANY
1112 EAST 222nd STREET • CLEVELAND 17, OHIO

improvements that can be obtained by heat treating the lacquers after applying them to test specimens. The properties obtained may be summarized as follows:

1. The cracks, once developed, remain open when the straining load is removed.
2. Strain sensitivity is improved.
3. The initial cracking response to strain is independent of the thickness of the coating within reasonable limits.
4. The coating does not flake until the specimen has been deformed plastically.
5. Tests results are not affected by moderate changes in temperature and humidity.

The heat treatment used consisted of keeping the coated specimen at 115 C for 24 hours. The resin in this lacquer has a melting point of 90 to 100 C. By varying the temperature from 70 to 115 C, it was found that strain sensitivity improved with increasing temperature.

Cooling of the specimen was controlled carefully. If the lacquer is cooled rapidly, "crazing" occurs. While the presence of craze lines does not affect the sensitivity of the lacquer, crack patterns will end at their junction with craze lines and well defined patterns will not be possible.

In dealing with dynamic stresses, this heat treatment offers a particular advantage. Normally these cracks can be observed only if some form of stroboscope is used. However, since the heat treated lacquers retain the crack patterns after the load has been removed, the apparatus can be shut down at intervals and the cracks examined or photographed as desired.

Having obtained the directions of the principal stresses from crack formations, the normal procedure of using more accurate resistance-type strain gages at chosen positions to obtain the exact value of stresses is used.

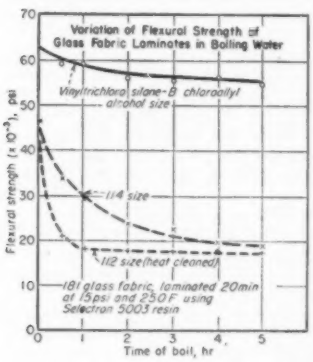
Moisture-Resistant Laminates

From "Glass Fiber Polyester Laminates Having High Resistance to Moisture", by Luther L. Yaeger, Bjorksten Research Laboratories, presented on March 1, 1951 at the annual meeting of the Reinforced Plastic Division of the Society of the Plastics Industry.

GLASS FIBER POLYESTER LAMINATES provide ease of fabrication, high strength and low weight. They are widely used but their utility has been greatly limited by the fact that the mechanical strength properties have been radically reduced on exposure

to water and high humidities. This was caused by the fact that existing treatments or "sizes" applied to the glass did not result in sufficiently strong bonding between the polyester resin and glass fibers. Until now the best results were obtained, for example, with a complex chromium methacrylate size "114" and silicone size "113" (see "Reinforced Plastics" by Richard J. Francis, February PRODUCT ENGINEERING). Laminates so treated show up to 40 percent flexural strengths on immersion.

Such laminates can now be made highly resistant to water and humidity by applying to the glass fiber a treatment of vinyl chloro silane, followed by an after-wash with water. It is believed that the chlorine is hydrolized off in such manner that the silicone atom in the vinyl chloro silane molecule becomes tied directly to the glass, and that the vinyl grouping will react and participate in the polymerization of the resin, so that an actual bond is formed between the glass and the resin. The result is that the resistance to drastic treatments with water is radically improved, as shown in the accompanying curves. A similar relationship exists on room temperature immersion tests, a 30-day water immersion being roughly comparable to boiling 3 hr.



A still further improvement was obtained by applying betachloro allyl alcohol in conjunction with this treatment. This improvement can be obtained with any of the principal polyesters commercially available.

The vinyl chloro silane treatment is applied either in vapor phase, or by immersion in an organic solvent solution of this agent, with subsequent drying. There is nothing particularly critical in the process. The new glass fiber reinforced polyester plastic was primarily developed in cooperation with the Air Force for structural parts of military planes.

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FRACTIONAL H.P. MOTORS
UNIVERSAL AND DIRECT CURRENT 1/1000 TO 1/4 H.P.
SHADED POLE 1/2000 TO 1/15 H.P. ★ INDUCTION TYPES 1/1400 TO 1/5 H.P.
You can tell a motor by the company it keeps!
Lots of dependable power in a small package—that's EMC MODEL 11B chosen by GELLMAN MANUFACTURING CO. to power the famous line of Sew-Gem sewing machines.
EMC has long had an outstanding reputation in manufacturing sewing machine motors. With the development of a new die cast case for Gellman, new streamlined appearance has been combined with top performance.
EMC Model 11B features flat-sided construction for easy mounting, is available in several stacking lengths for various output power. Rated 1/20 H.P., Model 11B also is widely used for adding machines, calculators and in many defense applications.
Take a tip from well-known companies. Check with EMC and CYCLOHM on your small motor requirements.
For information about EMC Model 11B or any of the famous EMC Universal, Direct Current or Shaded Pole Motors and CYCLOHM Induction Motors, write for our catalog.
EMC and CYCLOHM fractional H.P. motors are available with or without gear units, are easily adaptable to DEFENSE APPLICATIONS.
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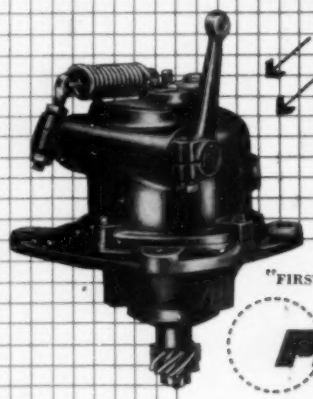
DIVISIONS EMC ELECTRIC MOTOR CORP. · Cyclohm MOTOR CORP.

ENGINE SPEED CONTROL

MILES-PER-HOUR RESTRICTION

OVER-SPEED PROTECTION



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OUR READERS SAY

Interplanetary Rocket Design?

To the Editor:

I would be very much obliged if you would be good enough to send me reprints or tearsheets of the following article from your Journal for use in our Society's Abstracts Section and Library: Ninety Pairs of Brakes Decelerate Rocket Propelled Sled, March, 1950. —J. HUMPHRIES

The British Interplanetary Society
London, England

Negligible Error

To the Editor:

The comment of your contributor, Victor Tatarinov, on page 223 of your March 1951 issue is valuable and we thank him for it. He writes from far Pilsen, Czechoslovakia, formerly Bohemia, where the golden beer originates. He says he cannot solve his problem of a magnet bobbin with my nomograph shown in the August 1949 issue of PRODUCT ENGINEERING because the Q scale is too short to intersect secant II. By merely lengthening scale Q (less than 2 in. in this case) and then proceeding with sec. III, he can obtain the result, 762 ft of wire, which he has calculated from the formula, upper left on same page. This extension of a turning scale is useful to increase its range.

Mr. Tatarinov says the formula is faulty because it implies concentric circles for the winding, when they are really spirals. For fine wires I have always thought this approximation to be quite negligible. He calculates the true length for spirals to be 684 ft.

However, they are not compared on the same basis. The winding space to be filled is 12.5 layers, and he assumes 13. Therefore, D is larger, and more wire will be needed. The number of spiral turns is 13 lines 80 turns per layer or 1,040 in all. He asks for 1,000 turns not ampere turns as he says in error. Taking 1,040 as the number of circular turns, 738 ft equals a mean turn (lower figure at right). This gives 779 ft, only 5 ft too short (entirely negligible). This shows our formula (and nomogram), while still approximate, are quite close. There is no point in computing spiral

WITH PERMITE ALUMINUM CASTINGS

A change from heavy metal to lightweight Permite Aluminum Castings can bring you these definite cost cutting savings:

1. Save on Cost of Handling

Permite Aluminum Castings are approximately 60% lighter than cast iron and 65% lighter than steel, brass and bronze. They're lighter to handle, lighter to assemble, lighter to ship as a finished product. So you cut handling costs all along the line!

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The consistent uniformity of Permite Aluminum Castings within close tolerances makes only a minimum of machining necessary. Higher machine speeds and deeper cuts are practical with Permite Aluminum Castings, with only slight changes in tool contours. Time spent per unit in shaper, drill press or milling machine is appreciably less! And aluminum stays bright without painting or expensive plated coatings.

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High tensile strength; resistance to corrosion; rapid heat transfer; and special to-fit-the-job designing by Permite engineers enable Permite Castings to give longer, better service! You save three ways with Permite and get better appearance, a better product.

PERMITE

Why not write us about your castings requirements and get our recommendations and quotations?

ALUMINUM INDUSTRIES, INC.

CINCINNATI 25, OHIO

ALUMINUM PERMANENT MOLD, SAND and DIE CASTINGS...HARDENED, GROUND and FORGED STEEL PARTS

"I NEVER KNEW OUR PARTS COULD BE MADE THAT WAY—AND SO MUCH BETTER, TOO!"
Yes, Pheoll "COLD HEADING" AND ROLL THREADING PROCESSES MAKE BETTER PARTS...
Stronger, Faster, Cheaper

Countless small parts usually made by conventional turning processes — by stamping, drawing, casting or molding — can be made *better . . . stronger . . . cheaper* by *cold-heading* and roll threading.

Machining of Cold-Headed Parts is hardly ever necessary because shank and head dimensions can be held to very close tolerances. Rolled threads are produced to American Standard dimensions.

Here are just a few of the many parts formed or roll threaded . . .

Screws	Plastic Inserts	Stems
Bolts	Thumb Screws	Arms
Studs	Wing Nuts	Plugs
Rivets	Small Gears	Prongs
Rods	Tongue—Clevis	Points
Links	Segments	Hooks

Single or multiple secondary operations can be performed on cold-headed parts to produce special characteristics required to fit the part for its particular application. These secondary operations include drilling, tapping, milling, shaving, flattening, notching, flanging, trimming, serrating, bending, off-setting, slotting, fluting, swaging, knurling, pointing, heat treating, plating and finishing.

ARE YOU MISSING THIS SAVING?

Write or call in a Pheoll engineer. Explain your production problems. He will tell you where you can save money, speed production, improve your product appearance.

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turns except as a mathematical exercise.

The formula is not restricted to integral numbers of layers and turns per layer but is wholly areal. It regards each wire as a square 1/256 sq in. area, filling a winding space of 5 x 13/16 or 4.06 sq in. This divided by $1/16^2$ equals 1,040 turns. For series coils of a few turns of large wire, the formula is not applicable.

—CARL P. NACHOD
Nachod & U. S. Signal Co., Inc.

Good Reason

To the Editor:

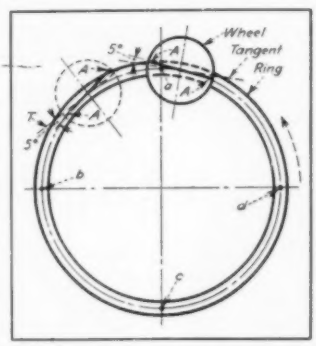
I received the February issue of your publication, and I am returning it today under separate registered cover. Please do not send me any more issues, because I don't know English, your magazine cannot interest me.

—VILLA PIERO
Monza, Italy

Come On, You Designers

To the Editor:

I have a problem in mechanism, which I believe you might be able to assist me to solve through the great amount of data your magazine has accumulated on such devices.



In the diagram, the ring rotatively supports the wheel, and is rotated by some means, so as to turn in a counter-wise direction. The wheel is connected in a way such that it reverses its relative position four times for each revolution of the supporting ring. As the wheel approaches top center (point a), the line A-A across its diameter is at some small angle, say 5 deg, to the horizontal (left side higher). As it passes through the top center and begins to descend, its position is changed, and line A-A maintains this same angle with the tangent but in the other direction. The wheel

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Another Interesting Bearing Application from the Orange Engineering Files

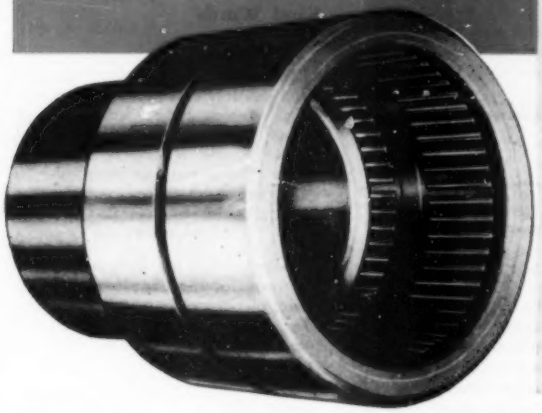
H. J. RUESCH MACHINE COMPANY not only fights friction but improves product performance

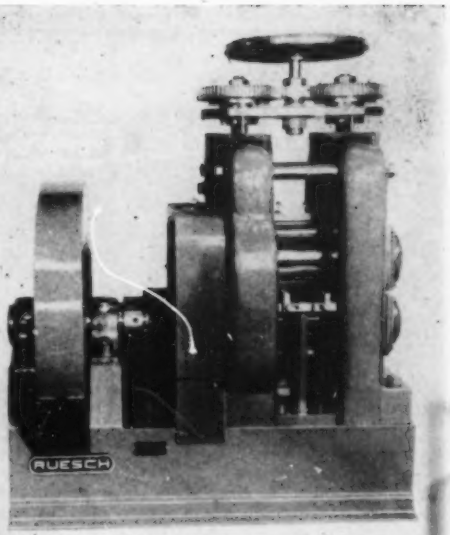
—with

ORANGE

Cage Type

NEEDLE BEARINGS





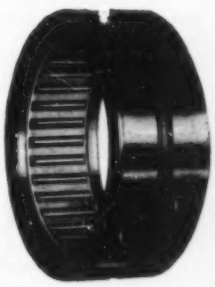
RUESCH ROLLING MILL for rolling hot and cold lead, tin and zinc ingots used in the manufacture of collapsible tubes.

- **OBTAINS** greater capacity for the size bearings required
- **MEETS** heavy load requirements within limited space
- **EXTREMELY** even running greatly reduces previous marking on rolled surfaces

Four double-row Orange Cage Type Needle Bearings, 5½" shaft dia. and 7 "O. D., are used on the roll journals. Five years' experience has proved highly satisfactory.

IN addition to the compactness, high load capacity and even-running emphasized in the application above, Orange Cage Type Needle Bearings are outstanding for high speed operations —spindles—overhung mountings—or other applications where misaligned mountings or uneven loadings are likely to occur.

All rollers are held in permanent alignment by a free-floating, land-riding cage made of anti-friction, non-ferrous metal. Rollers can not skew while running. Internal clearances can be precision controlled to meet exacting requirements. Rollers and races are "Pentrate" finished to reduce corrosion and friction. All factors combine to give Orange Cage Type Needle Bearings longer life expectancy in your equipment.



Left: Standard Orange Cage Type Needle Bearing, available with or without inner race, sizes ½" to 8" shaft dia. Double and triple row bearings made to order.

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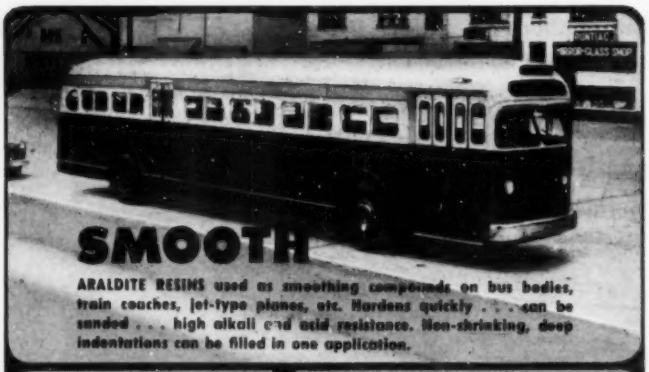
WRITE FOR CAGE TYPE ENGINEERING DATA BOOK giving further details.

ORANGE ROLLER BEARING CO., Inc. 561 Main St., Orange, N. J.

ORANGE



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ARALDITE RESINS used as smoothing compounds on bus bodies, train coaches, jet-type planes, etc. Hardens quickly . . . can be sanded . . . high alkali and acid resistance. Non-shrinking, deep indentations can be filled in one application.

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ARALDITE RESINS durably bond boron carbide tips to stems of aluminum pestles. Also bonds other heat-resistant materials, joins aluminum and zinc die-castings, pole pieces on magnets, etc.

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Fabricators seeking new, improved, simplified, time-and money saving bonding, casting and coating mediums, will find in these new but already extensively applied resins, an exceptional opportunity to put their ideas to work. Details of the properties and typical applications for Araldite Resins are fully described in newly published technical manuals, free upon request written on Company letterhead.

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continues to rotate in this position until it passes through point (b) then its position is reversed; by momentarily rotating clockwise, it assumes a position with the same angle to the tangent. When wheel reaches bottom center (point c), its rotation is again reversed and now turning counter-clockwise, it once more reverses the tangent by the same number of degrees. This relative position of the wheel to the ring continues until the wheel reaches the point (d). Then by turning clockwise line A-A and the tangent resume the original position shown in the figure. It would also be convenient to be able to adjust the wheel so that line A-A would maintain angles other than 5 degrees.

—A. I. R.
Farmingdale, L. I., N. Y.

Ed—Several suggestions have already been offered by members of the staff and others. However, perhaps some of our readers may wish to send in solutions of this problem.

Kind Words

To the Editor:

Thank you for the copies of the article "Electrolytic and Chemical Finishes." Everybody here was very much pleased with the presentation, and we are very happy to have the additional copies. Thank your for your offer to send the transparency used for the four color cut. —L. B. CONRATH
Aluminum Co. of America

Ed—Enclosed is the kodachrome that was used for the plate in the article "Electrolytic and Chemical Finishes". We are glad to hear that you are pleased with our treatment.

Some Job

To the Editor:

We want all possible information regarding friction clutches, flexible couplings and variable speed gears. Can you supply us this information either in the way of appropriate books or otherwise? —M. HOSS
Anciens Atelius Van Acker
Ganá, Belgium

Ed—Enclosed are two inserts which we have run within the past two years on (1) "Designing With Dollars" and (2) "Designing for Lower Costs". In each of these inserts you will find a considerable amount of information on friction clutches and flexible couplings with a listing at the end of the articles naming those con-

cerns here in this country who are quite active in the development of such devices.

Frankly, to supply you with all of the information that we have run on such components would require a two week study by us of the past issues of PRODUCT ENGINEERING. It is thought you can get most of the information that you want out of these inserts. However, there is one other treatment of a variable speed device in which you may be interested, namely "Fluid Power Transmissions". A copy of this is also enclosed for your perusal.

If this doesn't give you what you are after, it is suggested that you secure a copy of "Thomas' Register" through one of the libraries or through direct subscription from the Thomas Publishing Co., 461 Eighth Ave., New York 1, N. Y. You will find this directory invaluable since it lists all products manufactured by companies in the United States.

Too Trusting

To the Editor:

In the latter part of 1949 one issue of PRODUCT ENGINEERING contained a special report on Titanium. I used to have this special report, but because my generosity overcame my better sense, I am no longer its possessor. I lent it to an interested party who failed to return it. I would like very much to receive a reprint of this if it is at all available.

—R. J. THOMPSON, MAJOR, USAF
Norton Air Force Base, Calif.

Ed—We are sending you the reprint requested.

A Heavy Order

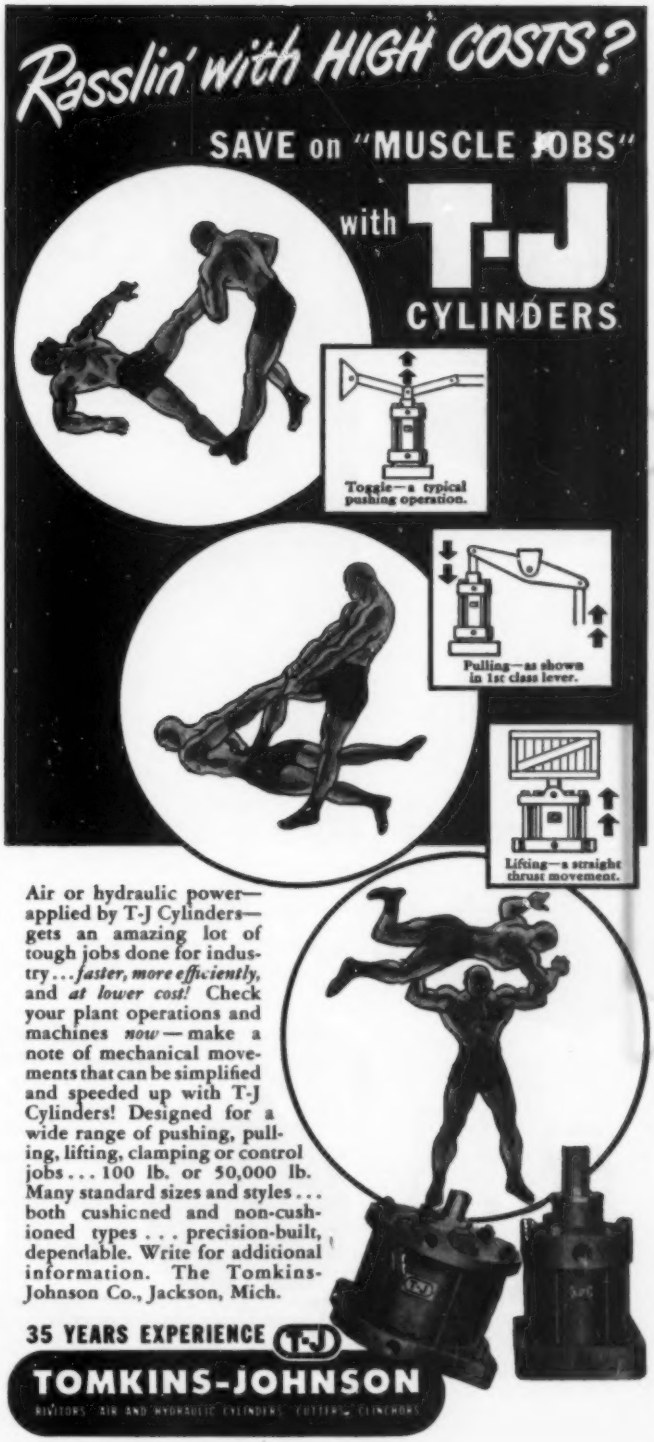
To the Editor:

Knowing that you are able to provide all kind of printed matter on technical equipment and industrial installations, I should like to ask you to send us folders and catalogs pertaining to the engineering fields indicated below.

Especially interesting to my factory are small steam generators, boilers and burners, as well as all kinds of lifting gadgets for light and heavy weights, blocks, cranes, travelling cranes, etc.

Lock and dam installations are also most important to me, as well as all implements which are essential to this particular industry.

What I would like to receive is a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SAVE on "MUSCLE JOBS"
with T-J
CYLINDERS
Toggle—a typical pushing operation.
Pulling—as shown in 1st class lever.
Lifting—a straight thrust movement.
Air or hydraulic power—applied by T-J Cylinders—gets an amazing lot of tough jobs done for industry... faster, more efficiently, and at lower cost! Check your plant operations and machines now—make a note of mechanical movements that can be simplified and speeded up with T-J Cylinders! Designed for a wide range of pushing, pulling, lifting, clamping or control jobs... 100 lb. or 50,000 lb. Many standard sizes and styles... both cushioned and non-cushioned types... precision-built, dependable. Write for additional information. The Tomkins-Johnson Co., Jackson, Mich.
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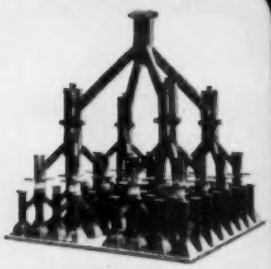
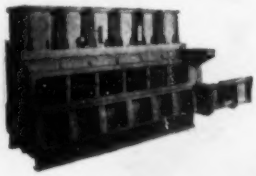


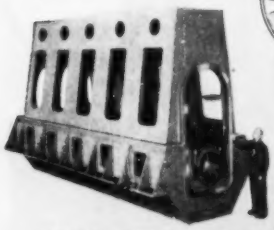
One of Several Parts of a Catalytic Cracking Plant Produced for the Petroleum Industry.

Pressure Vessels for the Chemical and Allied Industries.

Heavy Press and Machine Frames and Bases for the Machine Tool Industry.

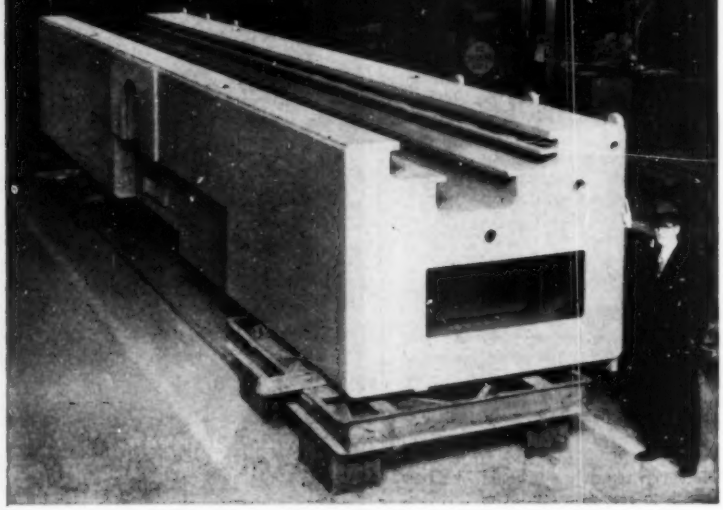


Diesel Engine Crank Cases and Frames for the Marine and Electro-Motive Field.



Crank Cases, Frames, and other Parts for Manufacturers of Marine Steam Engines of Uniflow or Multiple Expansion Type.

Steel-Weld FABRICATION



Use WELDED STEEL for Greater Strength with Less Weight!

This Steel-Weld Fabricated broach bed, thirty-seven feet long and weighing approximately thirty-five tons, is indicative of Mahon fabricating and handling facilities. Hundreds of such heavy machinery parts and assemblies are produced by Mahon annually for manufacturers throughout the country. If you can employ welded steel to advantage in your product, you will find in the Mahon Company an unique source with complete, modern fabricating and machining facilities . . . a source where skillful designing and advanced fabricating technique are supplemented by master craftsmanship which assures you a smoother, finer appearing job embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
DETROIT 34, MICHIGAN

Engineers and Fabricators of Steel in Any Form for Any Purpose

MAHON

complete list of items that may be available so that I can choose among them what is most needed at present. This varies according to demand.

—ANTONIO VOGG
Port Alegre, Brazil

Ed—We are sorry to say that we do not carry a stock of bulletins. However, in every issue of PRODUCT ENGINEERING there is a list of bulletins issued by various firms. We suggest you pick out the items of interest to you and write to the companies concerned or send your request to us by filling out the Reader Service Reply Card.

Popular Articles

To the Editor:

The October 1950 issue of PRODUCT ENGINEERING had an excellent article concerning 12 Ideas for Feeding, Sorting and Counting Mechanisms by Mr. William Schwartz on pages 144 to 149. I'd like to have either a reprint or tear sheets of this for our office files.

Also, I'd like to know if reprints have been made of Mr. Rappaport's series of articles on Intermittent Mechanisms which appeared in July 1949, External Geneva; August 1949, Internal Geneva; October 1949, Spherical Geneva; January 1950, 3 Gear Drive; and April 1950, Cardioid Drive. If they are available, I'd like to have a copy of each of these too.

Articles of this type are probably well accepted by other design and development engineers too and I suppose you have received many requests for reprints of these.

—GLENN W. HEWETT
General Electric Co.

Ed—We regret to say that we do not have any available copies of the articles you requested, because of the large number of requests for reprints. However, we will photostat the articles at a cost of 40 cents per page, if you so desire.

Framed Covers

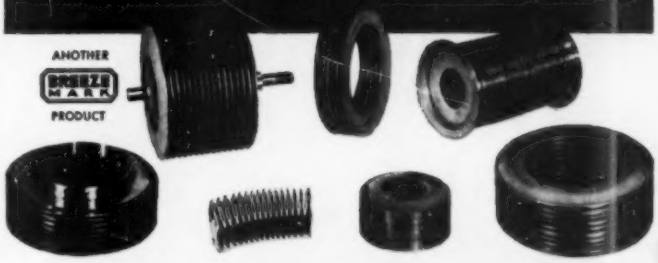
To the Editor:

Attached are three transparencies of the Color Studio of GM Styling Section. They're the only ones we have, so whenever you're through with them we'd appreciate their return.

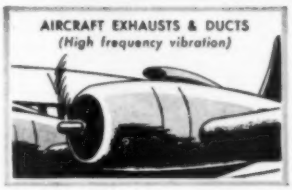
—JOSEPH H. KARSHNER
General Motors Corp.

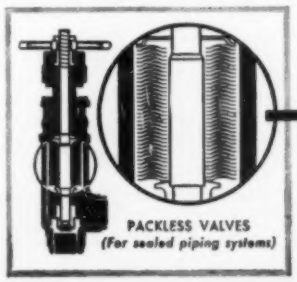
Ed—We have never seen more gorgeous color than was in these three

BREEZE Job-Engineered BELLOWS



...Give LASTING PROTECTION Where Ordinary Bellows Fail





Breeze welded diaphragm bellows meet the operating life cycle of any equipment in which they are used *because every Breeze bellows design is individually engineered and built for the job.*

Breeze has no "stock bellows," but if you have a vibration problem in ducts, large or small, or want permanently sealed valve enclosures in any type of piping system, or need bellows for torque transmission or other uses, Breeze experience can quickly provide the answer . . . and production can meet your requirements.

A Breeze bellows is dependable because each diaphragm is designed to work well within its elastic limit. This is accomplished by thorough analysis of each application and careful design of the bellows to withstand all requirements. "Job engineering" each individual type eliminates makeshifts, assures efficient performance.

Breeze bellows are made in stainless steel, inconel, monel, nickel, steel, or other weldable alloys.

Feel free to consult us without obligation on your existing bellows requirements, or any other project where reliable welded diaphragm type bellows might solve a design problem.

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How's this for STRENGTH?

SUPER ACE GRADE—one of the many formulas of Ace Hard Rubber available for molded and extruded machine parts, has a tensile strength exceeding that of most plastics, and high impact strength, too!

Even more important than strength is the *durability* of hard rubber—its unusual toughness, high abrasion-resistance, excellent resistance to water, acids, alkalies, etc. Only glass-bonded mica has lower moisture absorption.

For instance: the accuracy of water meters depends on strength, long-life, and stability of the hard rubber parts—expected to last 10—even 20—years under water. Here fatigue resistance is vital, as the parts may go through 50,000,000 or more cycles in a lifetime.

With many different Ace Hard Rubber molding compounds, sheets, rods and tubes to choose from—also other Ace plastics such as Ace-Tex, Parian, Saran—you can select just the right combination of technical properties. And with our complete molding, extruding and fabricating facilities (among the world's largest) at your service, your job will be done the best way, the quickest.

Always check your Ace Handbook, pgs. 4 and 5, when selecting molding materials. If you haven't a copy of this valuable 60-pg. manual, *write today—it's free.*

ACE
HARD RUBBER and PLASTICS
AMERICAN HARD RUBBER COMPANY
11 MERCER STREET • NEW YORK 13, N. Y.

transparencies. Furthermore, I cannot quite understand why your photographer does not quit and make a million dollars on his own. I am holding two of the transparencies for use in the future color section that we have coming up.

As you may know, March contained the second in the Almen series and also had the cover of the bearing test machine in the laboratories. As usual, you get reprints and framed copies of the cover.

Now Everyone's Happy

Ed—On January 12, a remittance of $0.75 was received from Mr. Russell W. Henke of The Heil Co. by PRODUCT ENGINEERING. A check of the records revealed Mr. Henke had no unpaid accounts. Consequently, a request for enlightenment regarding the matter was sent him. Here is his answer.

To the Editor:

This is my second answer to your letter and plea regarding my rather ambiguous remittance of $0.75 to your company. My first answer must have become short circuited somewhere in your organization, since I have already received from you the article for which the money was forwarded. I had intended that the 75 cents be used to cover the cost of one reprint of "Designing With Dollars", which I indicated in an obscure manner on the money order card I mailed to you.

After receiving your letter asking what to do with the 75 cents, I answered to wit: "Use it for one reprint of 'Designing With Dollars' ". Subsequently, I received my copy of the article requested, but evidently someone forgot to inform you of the transaction.

I am happy—Keep my 75 cents.

—RUSSELL W. HENKE
The Heil Co.

New Idea for Tracing Drawings

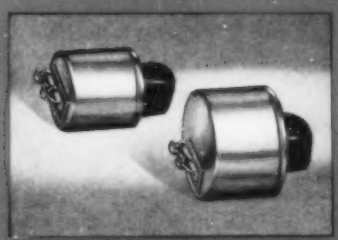
To the Editor:

This is a suggestion regarding the making of tracings which may be of interest to your readers. Instead of placing the tracing paper on top of the drawing to be traced we place the said drawing over the tracing paper, with one sheet of carbon paper between them, and another sheet of carbon paper under the tracing paper. We then simply draw over the lines of the drawing with firm pressure so as to obtain an opaque carbon impres-

Ohmite Rheostats, in nine sizes from 25 to 750 watts, meet all requirements of Specification JAN-R-22.

OHMITE RHEOSTATS

MEET REQUIREMENTS OF JOINT ARMY-NAVY SPECIFICATION JAN-R-22



Models N (enclosed) and J (enclosed)
Also AN 3155 (AN-R-14a)

TYPE	OHMITE MODEL	WATT RATING
RP10	N	25
RP11	N enclosed	12.5
RP15	J	50
RP16	J enclosed	25
RP20	G	75
RP25	K	100
RP30	L	150
RP35	P	225
RP40	H	300
RP45	R	500
RP50	T	750

OHMITE RHEOSTATS MEET THESE RIGID TESTS:

- ★ 5-Hour Vibration Test (Required for RP 10-11-15-16-20-25)
- ★ 50-Hour Salt-Spray Corrosion Test
- ★ 150-Hour 95% Humidity Electrolysis Test

and other tests as prescribed in Specification JAN-R-22

By meeting these severe Joint Army-Navy requirements, Ohmite Rheostats have proved what industry has long accepted as true—that they can be depended upon for unfailing performance under the toughest operating conditions. All-ceramic construction . . . a smoothly gliding metal-graphite brush . . . uniform windings locked in place by vitreous enamel . . . insure close control throughout years of trouble-free service. It will pay you to standardize on Ohmite Rheostats for your product.

Be Right with

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RHEOSTATS · RESISTORS · TAP SWITCHES

OHMITE MFG. CO., 4819 Flournoy St., Chicago 44, Ill.

OHMITE JAN-TYPE WIRE-WOUND RESISTORS

MEET REQUIREMENTS OF JOINT ARMY-NAVY SPECIFICATION JAN-R-26A

STYLES AND SIZES

TAB-TERMINAL TYPE

†Characteristics G and J

Style	Overall Length	Diameter	*Watts
RW-29	1-3/4"	1/2"	5
RW-30	1"	19/32"	8
RW-31	1-1/2"	19/32"	10
RW-32	2"	19/32"	12
RW-33	3"	19/32"	15
RW-34	5"	29/32"	30
RW-35	4"	29/32"	30
RW-36	6"	1-5/16"	60
RW-37	8"	1-5/16"	75
RW-38	8"	1-5/16"	100
RW-39	12"	1-5/16"	146

TAB-TERMINAL TYPE with terminal hole to clear No. 8 screw

†Characteristics G and J

Style	Overall Length	Diameter	*Watts
RW-40	3"	29/32"	34
RW-41	4"	29/32"	32
RW-42	4"	1-5/16"	69
RW-43	6"	1-5/16"	74
RW-44	8"	1-5/16"	100
RW-45	12"	1-5/16"	160
RW-46	10-1/2"	1-5/16"	135
RW-47	16-1/2"	1-9/16"	165

FERRULE-TERMINAL TYPE

†Characteristics G and J

Style	Overall Length	Diameter	*Watts
RW-10	11-7/16"	1-5/16"	100
RW-11	9-5/8"	1-5/16"	116
RW-12	7-7/16"	1-5/16"	86
RW-13	5-1/2"	1-1/16"	70
RW-14	4-7/16"	1-1/16"	60
RW-15	2-15/16"	3/4"	20
RW-16	2-3/8"	3/4"	14

FLAT (Stack Mounting) TAB-TERMINAL TYPE

Characteristics G and J

Style	Overall Length	Width of Core	Thickness of Core	*Watts
RW-20	1-1/2"	1-3/16"	1/4"	15
RW-21	2-1/4"	1-3/16"	1/4"	22
RW-22	4-3/4"	1-3/16"	1/4"	37
RW-23	6"	1-3/16"	1/4"	47
RW-24	7-1/8"	1-3/16"	1/4"	60

AXIAL-TERMINAL TYPE

Characteristics G and J

Style	Length of Core**	Diameter	*Watts
RW-53	1-3/8"	5/8"	5
RW-56	2"	5/8"	10

**3-1/2" wire leads

*Watts free air Mil Characteristic "G"

† Also available to meet requirements of Characteristics P, H, E, and D which were recently removed from Spec. JAN-R-26A. (Amend. 2)

Ohmite offers an unusually complete line of resistors that meet the most rigid requirements (Characteristics "G" and "J") of Joint Army-Navy Specification JAN-R-26A. To meet these requirements, resistors must pass severe moisture resistance and thermal shock tests. They are required to withstand strenuous vibration applied for five continuous hours. And, they must satisfy the requirements of many other tests, including momentary overload, mechanical strength, and terminal strength.

Of the 38 different resistor styles listed in JAN-R-26A, Ohmite offers 33 styles that meet these specifications. These styles represent the most popular resistors, and are available in a complete range of resistance values, in the types and sizes listed.

OHMITE MANUFACTURING COMPANY
4319 Flournoy St., Chicago 44, Ill.

Be Right with...

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RHEOSTATS • RESISTORS • TAP SWITCHES

sion on the both sides of the tracing paper. The advantage of this procedure lies in the greater ease with which the original drawing can be seen. Tracings having carbon paper lines make excellent prints.—F. SUTZ
Hart Pressed Steel Corp.

Preview

To the Editor:

I always enjoy the monthly opportunity of reading your very excellent publication PRODUCT ENGINEERING. The February, 1951 issue was especially interesting because of the summary on "Electrolytic and Chemical Finishes". Would it be possible for you to send me two or three sets of tear sheets on this article, in addition to the summary table which accompanies the article? —E. P. WHITE
Aluminum Co. of America

Ed—Your kind words regarding the article in our February issue, "Electrolytic and Chemical Finishes", are indeed appreciated. Enclosed are three reprints of this piece along with the gatefold.

As you may know, Mr. Vanden Berg has prepared a special article for us on Finishes for Aluminum which will appear in one of the forthcoming issues of PRODUCT ENGINEERING. This also will be illustrated in four colors.

Where Can I Get It?

Constant Speed by Mechanical Means

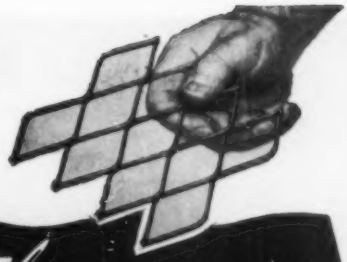
To the Editor:

I am seeking a solution to the problem of accomplishing constant speed from 115 v universal motors, say 1/20 hp, by mechanical means.

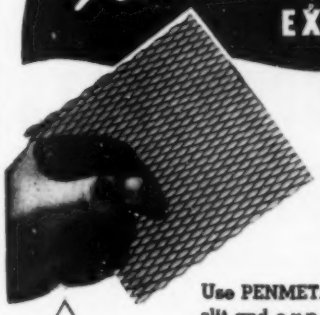
The usual way of accomplishing this is a centrifugal governor which opens and closes the electrical circuit in one of the motor windings. The food chopper or mix-master is an example of this mode of speed vibration. I want to hold one speed by purely mechanical means, just as the old steam engine governor does it. I cannot use electrical contacts that open and close.

The motors we plan to use will be 3,600 rpm and the speed will vary with the load and voltage, and of course the universal motor is supplied a-c or d-c current. The speed should be held constant and should also be

How to make a little metal go a long way



Penmetal
EXPANDED METAL



Save Critical Metals!
Don't Pay for the Holes

Use PENMETAL Expanded Metal,—solid sheet, slit and e-x-p-a-n-d-e-d to five or more times its original width.

Nothing punched out: nothing wasted. You get the *whole sheet*, 500% increased in area, increased too, in rigidity and strength due to the diamond-truss formation. You pay for the solid sheet, and get the advantages of greater area, lighter weight, free passage of light and air, but you *do not pay for the holes*. And that can be quite an item! Figure it out for yourself. When you buy a sheet 25% of which is perforated into a design, you lose 25% of the metal, and in addition, you pay for punching out the holes.

With PENMETAL Expanded Metal, you save metal, you save money, and you get a material of amazing versatility and utility. Made in large or small mesh, 1½" to 3/16", 22 gauge to 9 gauge thickness in carbon steel, stainless steel, Monel, Iconel, copper, aluminum and other metals, standard or flattened. Thousands of uses in construction, in industry and in product applications, are proving its economy, efficiency and decorative possibilities.

Our engineers may be able to suggest ways for you to use it to cut costs, increase production or to improve a product. Why not tell us your problem, and see what we can do with it?

82ND PENMETAL YEAR

Penmetal

PENN METAL COMPANY, INC.
General Sales Offices: 271 East 42nd Street, New York 17, N. Y.
District Sales Offices:
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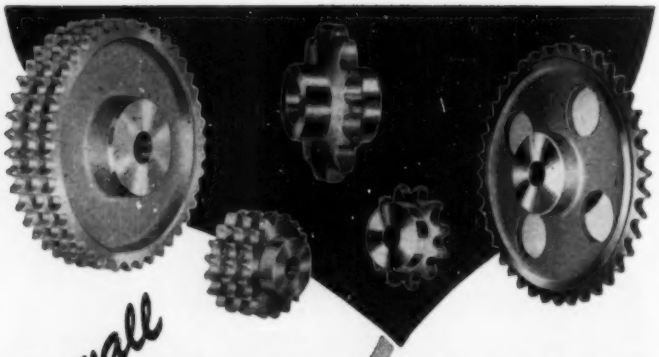
Seattle · Los Angeles · San Francisco · Dallas · Parkersburg, W. Va.



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If your product will permit a standard pitch, look it up in the Sewall Catalog of Stock Sprockets. Or let us send you an estimate on your special design. True running, durable gears and sprockets all add up to over-all quality in Sewall products.

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Complete facilities under one roof assures controlled quality and immediate delivery. Standard and "AN" specs. Specials to order.

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SCREW PRODUCTS COMPANY, INC.
33 GREENE STREET NEW YORK 13, N. Y.

adjustable plus and minus 10 percent of the 3,600 rated speed. The steam engine governor is as accurate a description of operation as can be given.

—G. M. M.
Wilmette, Ill.

Ed—We cannot help you with any specific information as how to obtain constant speed by mechanical means from fractional horsepower universal motors. However, we will print your request in our Readers Letter Department. It may be that some reader can suggest a way to approach your problem.

Enclosed you will find tearsheets of two articles that may be of some help in furnishing an idea that may lead to a solution of your problem. These articles are: "Mechanical Systems for Controlling Speed and Tension", December, 1950, p.85-89; "How to Obtain Constant Speed Motion Below 10 Rpm", December, 1949, p.118-119.

Brass Plating Aluminum

To the Editor:

We are very much interested in your article "Electrolytic and Chemical Finishes", in February 1951 issue of PRODUCT ENGINEERING. Can you advise us of any company that has developed a process for brass-plating aluminum? —W. J. HORVEREID
Minnesota Rubber and Gasket Co.

Ed—To our knowledge there is no company that has successfully developed a process for brass plating of aluminum. There is not too much call for this type of plating on a material like aluminum.

It is suggested, however, that you write directly to Mr. R. V. Vanden Berg, Aluminum Company of America, New Kensington, Pa. Mr. Vanden Berg is in charge of all finishing departments at Alcoa, and it is thought that he can supply you with the information you require.

Tubular Clip Fasteners

To the Editor:

In fabricating various types of sectional steel buildings lined with insulation panels, we encounter numerous fastener of the tubular clip type as can be solved by the use of some of the various attachment methods outlined in an article in the June, 1950 issue of PRODUCT ENGINEERING.

We are particularly interested in a fastener of the tubular clip type as shown in this article and would like to contact a manufacturer of this type

Be a wise bird about tubing

Bundyweld Tubing, double-walled from a single strip. Exclusive, patented beveled edge affords smoother joint, absence of bead, less chance for any leakage.

Why get yourself out on a limb with a tubing part that can't deliver the goods in your product?

Be like other wise birds and rely on Bundyweld . . . for lines that hold, come shaking or vibration, for coils that form right, or frames that are strong. The more stringent your needs, the better.

No other small-diameter tubing offers as much as this double-walled type of Bundy ® tubing. It's extra sturdy, won't leak under pressure or give under normal strain. It's thinner walled, conducts heat faster and fabricates with ease.

For details, just get in touch with headquarters for small-diameter tubing . . . today.

Bundy Tubing Company

DETROIT 14, MICHIGAN

World's largest producer of small-diameter tubing

AFFILIATED PLANTS IN ENGLAND, FRANCE AND GERMANY

Typical of innumerable special shapes cast centrifugally *by Shenango, these splined "star" rolls of Meehanite Metal are used to convey coated cloth and synthetic material through a hot fast-drying process.*

Why these rolls will do a **better** job, **longer!**

WHEN symmetrical shapes, such as these "star" rolls, are cast *centrifugally* by Shenango, they gain qualities that can't be matched in ordinary castings.

For example, metal for metal there's pressure-dense grain for finer, smoother finish; higher tensile to better resist stress and impact; freedom from sand inclusions, blow holes and other hidden defects to reduce rejects and avoid costly, unexpected failure.

So, when it comes to symmetrical shapes, large or small, ferrous or non-ferrous, you'll always be time and money ahead when you specify Shenango *centrifugal* castings . . . either rough or precision finished in the modern Shenango shops.

HELPFUL BULLETINS

Bulletin No. 150 covers Shenango non-ferrous centrifugally cast parts; Bulletin No. 151 for parts of Meehanite Metal, Ni-Resist and other special iron alloys. Either or both are yours for the asking.

SHENANGO-PENN MOLD COMPANY
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SHENANGO

ALL RED BRONZES · MANGANESE BRONZES · ALUMINUM BRONZES
MONEL METAL · NI-RESIST · MEEHANITE METAL

of fastener. If it is possible, we should like to have the address of a concern or concerns specializing in the manufacture of a line of similar attachment items.

—C. H. PUTSCHE
Braden Steel Corp.

Ed—Manufacturers of tubular clip type fasteners are: Tinnerman Products Inc., Cleveland 1, Ohio and United Carr Fastener Corporation, Cambridge 42, Mass.

Inventor to the Rescue

To the Editor:

On page 151 of PRODUCT ENGINEERING for December 1950, you mention the National Inventors Council and their attempts to enlist the aid of inventors in solving military problems. I would greatly appreciate receiving the address of this Council.

—WILLIAM F. BERCK
Ralph N. Brodie Co., Inc.

Ed—Inquiries concerning the National Inventors Council are handled by Mr. John Green, Office of Technical Services, Department of Commerce, Washington, D. C.

Student Aid

To the Editor:

I am a senior mechanical engineering student at the University of Cincinnati. For the partial fulfillment of the requirements for a degree in mechanical engineering, a thesis is required, the subject for which I have chosen oil seals.

In your magazine, PRODUCT ENGINEERING, May 1950 issue, page 142-147, I came across the article by R. S. Rainey, titled "Which Shaft Seal?". If it would be possible, I would like to obtain a copy of this article for reference purposes.

If your organization could give me leads to any additional information on oil seals and sealing devices for rotating shafts, I would appreciate it very much. Any leads to publications since the first of the year would be most welcome. I have referred to the "Engineering Index" for the article mentioned above and others, but it is not possible to obtain them for home study purposes.

—CHARLES C. MANGOLD
Cincinnati, Ohio

Ed—Enclosed you will find the article concerning oil seals, which you asked for. For further information regarding oil seals and sealing devices, we suggest you write to the following

HERE'S WHY THE *NEW* LODOVER IS

Designed with LAPLANT-CHOATE *HYDRAULIC UNITS*

FINGER-TIP BUCKET CONTROL

Positive, sensitive LPC hydraulic units, especially designed for the Lodover, give instant response to controls, assuring the fast, smooth operation that steps up productive output.

SMOOTH, SAFE POWER

Heavy hydraulic down pressure increases digging power. As bucket moves overhead, smooth hydraulic power prevents spillage.

SYNCHRONIZED BUCKET SPEEDS

For digging, overhead travel and dumping, the four double-acting hydraulic cylinders automatically synchronize bucket speeds for maximum output.

EASY OPERATION

With all the advantages of LPC hydraulic units utilized, operation is simple. The operator simply moves the levers . . . hydraulic power does the rest.

Design YOUR Product for Better Performance

ANY product designed with full hydraulic operation gives you sales advantages that keep you well ahead of competition. LaPlant-Choate Hydraulic Units provide maximum power for equipment that needs muscle . . . fast, smooth operation and instant response to controls for jobs that need speed and precision . . . and they are easily adaptable to any type of product.

Used for over 25 years on LaPlant-Choate's own earth moving equipment, these hydraulic units are job-proved by the most punishing of operating conditions. When you specify LPC for *your* products, you are assured the best in hydraulic efficiency and economy. For complete details, write for Bulletin B-1152B LaPLANT-CHOATE MANUFACTURING CO., INC., Cedar Rapids, Iowa.

SIMPLICITY OF THE LPC SINGLE-UNIT FLUID POWER CONTROL

The extreme simplicity of this compact, single-unit LaPlant-Choate power control is a real sales point for *any* equipment that can be operated hydraulically.

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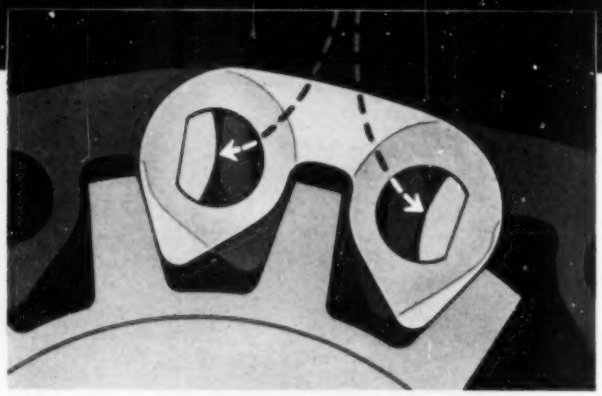

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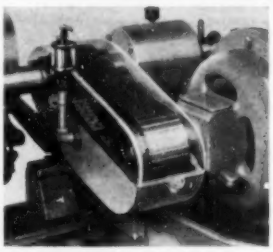

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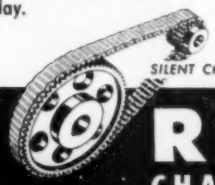

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firms: Armstrong Cork Co., Gaskets and Packing Dept., 7107 Arch St., Lancaster, Pa.; National Motor Bearing Co., Redwood City, Calif.; Chicago Rawhide Mfg. Co., Sirvene Div., 1299 Elston Ave., Chicago 22, Ill.; and General Tire and Rubber Co., Mechanical Goods Div., Wabash, Ind.

Glass Moulds

To the Editor:

I would like some information about materials, mechanics and methods used for the making of mould for the manufacturing of glass articles such as tumblers, bottles, etc.

Do you have some literature on hand covering this branch of mould making? —P. J. REMPEL
Kitchener, Ont., Canada

Ed—We suggest you write to any of the following companies: Washington Mold Machine & Foundry Co., Washington, Pa.; T. H. Sloan Co., Washington, Pa.; and Kelly Foundry & Machine Co., Elkins, West Virginia.

Powdered Alloy Steels For Engine Valves

To the Editor:

In your article "New Techniques Cut Cost of Powder Parts" reference is made to an auto engine builder who is investigating the possibilities of using powdered alloy steels for engine valves. Can you furnish further details? I should like to follow this up because from a production point of view the idea has definite possibilities. B. T. GILBART
Valves Limited
Coventry, England

Ed—The company who has been quite active in the development of powdered alloy steels for engine valves is Thompson Products, 2196 Clarkwood Rd., Cleveland, Ohio. It is suggested that you address any inquiry you may have to Mr. T. R. Thoren, Director of Development.

Thompson Products is, of course, a primary automotive supplier and of late has done considerable work on the development of sintered alloy turbine blades for gas turbine application. Perhaps you have seen something in the literature regarding them also.

As a metal supplier, The New Jersey Zinc Co., 160 Front St., New York, N. Y., can supply you with names of manufacturers that are doing a lot in powder metallurgy.

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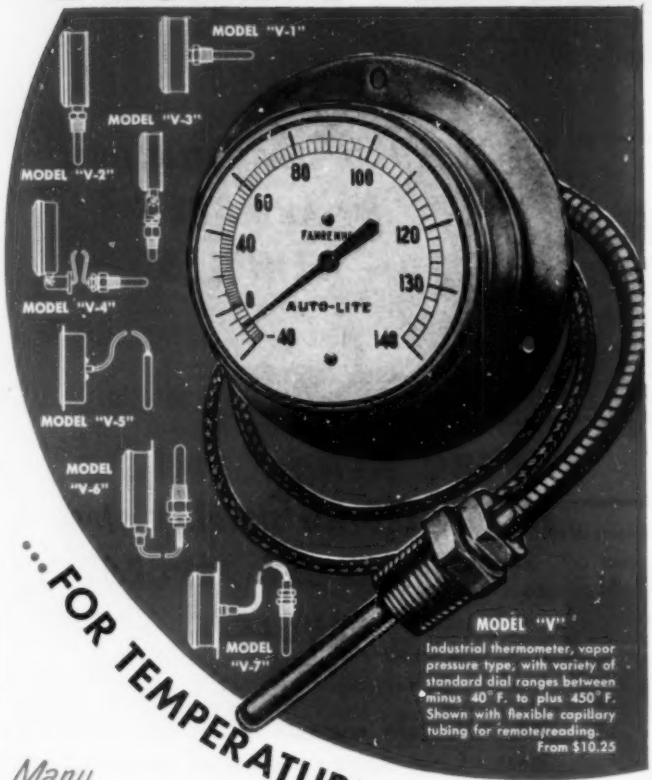
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NEW BOOKS

Bibliography on Industrial Radiology

HERBERT R. ISENBURGER. *Soft cover loose leaf folder, 8½ x 11 in., 19 pages. Copyrighted by St. John X-Ray Laboratory, Clifton, N. J.* $2.

In 1943 John Wiley & Sons published the second edition of "Industrial Radiology" by Ancel St. John and Herbert R. Isenburger. That book included a bibliography up to 1942. Periodically, since then, that bibliography has been supplemented by additions. This present publication is the third supplement, and in it the years 1948 to 1950 are covered.

Mechanical Engineers' Handbook, Fifth Edition

Edited by LIONEL S. MARKS, *Gordon McKay, Professor of Mechanical Engineering, Emeritus Harvard University. 6 x 9 in., 2236 pages. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y.* $15.

Indexed under more than 12,000 entries, the information contained in this book is designed to give answers in every branch of mechanical engineering. This fifth edition has an enlarged format to give greater legibility of the data, and there is much new as well as revised subject matter. Included in this under theory are fluid mechanics, stresses in turbine disks, transonic and supersonic aerodynamics, aircraft jet propulsion, rockets and television; under processes are radiant or panel heating, solar heating, heat pumps, compression distillation, high vacuum pumps, casting methods, industrial supersonics and automatic process control; under materials are ferrous and non-ferrous alloys, super alloys for high temperatures, plastics, elastomers, silicones, adhesives, explosives and rocket fuels; under power are gas turbines and atomic power.

The book is divided into sixteen sections; the data of each has been compiled by a group of authorities in the field it covers. The sections follow each other according to a plan whereby the fundamentals of the whole field of mechanical engineering are explored in the first sections which then lead in later sections into each of the specialized fields.

Section I is made up of mathematical tables such as the trignometric functions and weights and measures such

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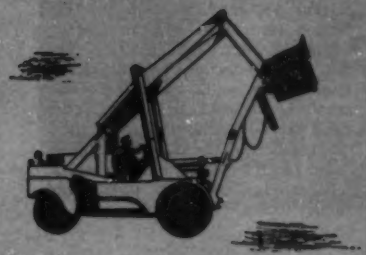

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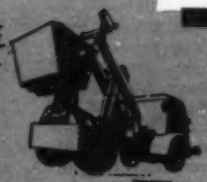

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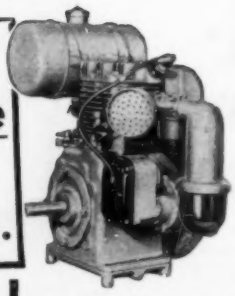

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3000 R.P.M.	4.2	5.9
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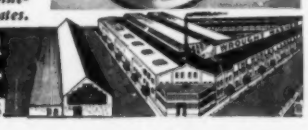

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as specific gravity and density. Section 2 covers the subject of mathematics from arithmetic to vector analysis. Those matters in physics which concern the mechanical engineer, namely, mechanics of solids and liquids and heat follow in Sections 3 and 4. This leads into strength of materials which makes up Section 5 and materials of engineering in Section 6. From here on, the specialized fields are entered. They include: Section 7, fuels and furnaces; Section 8, power generation, which includes all sources of power from the steam engine to atomic power; Section 9, hoisting and conveying; Section 11, transportation from automobiles to aircraft; Section 12, building construction and equipment; Section 13, machine shop practice; Section 14, pumps and compressors; Section 15, electrical engineering. The last section, Section 16, includes a number of miscellaneous subjects that cannot be conveniently included under more general headings. Among these are engineering measurements, automatic controls, surveying, mechanical refrigeration, lubrication, patents and similar topics.

Sourcebook on Atomic Energy

SAMUEL GLASSTONE, *Consultant to the United States Atomic Energy Commission;* 546 *pages,* 6 x 9 *in. Published by D. Van Nostrand Company, Inc.,* 250 *Fourth Ave. New York* 3, *N. Y.* $2.90

This sourcebook assembles, in one readable narrative, the important facts about the past history, present status, and the possible future of atomic science. The volume does not deal with the atomic bomb and the terrors of atomic warfare. It comprises a balanced guide to all aspects of atomic energy, in peace as much as in war. It supplies the general reader, a well as scientists and engineers, with a volume of authoritative atomic facts.

Beginning with the earliest theories of the atom and its structure, the author describes the growth of thought and knowledge in the field, the development of the theories of the nature of electricity and energy, the discovery of the phenomenon of radioactivity, and continues through the study of isotopes to present cyclotrons, betatrons, atomic piles, and newly created elements.

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atomic disintegration and many others. The author also traces the historic origin of the principal terms used in our new atomic language.

A reader with only a rudimentary knowledge of science or mathematics should be able to follow this narrative without difficulty.

In his search for background material, the author studied the work in the Atomic Energy Commission's laboratories and the files of reports on scientific work. The manuscript was reviewed for technical accuracy by scientists associated with the national atomic energy program.

Mechanics of Materials

H. D. CONWAY, *Professor of Engineering Mechanics, Cornell University. 6 x 9 in., 325 pages. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y.* $6.35.

One of the problems in teaching engineering students is that of providing them with a sound understanding of the assumptions upon which the textbook formulas are based. In later professional work, he may, with a poor background, be inclined to extrapolate certain formulas to problems far beyond their range of validity. To avoid this situation, the author has endeavored to clearly emphasize all assumptions. This book was undertaken as a result of several years of teaching during which time the needs of the student was carefully studied.

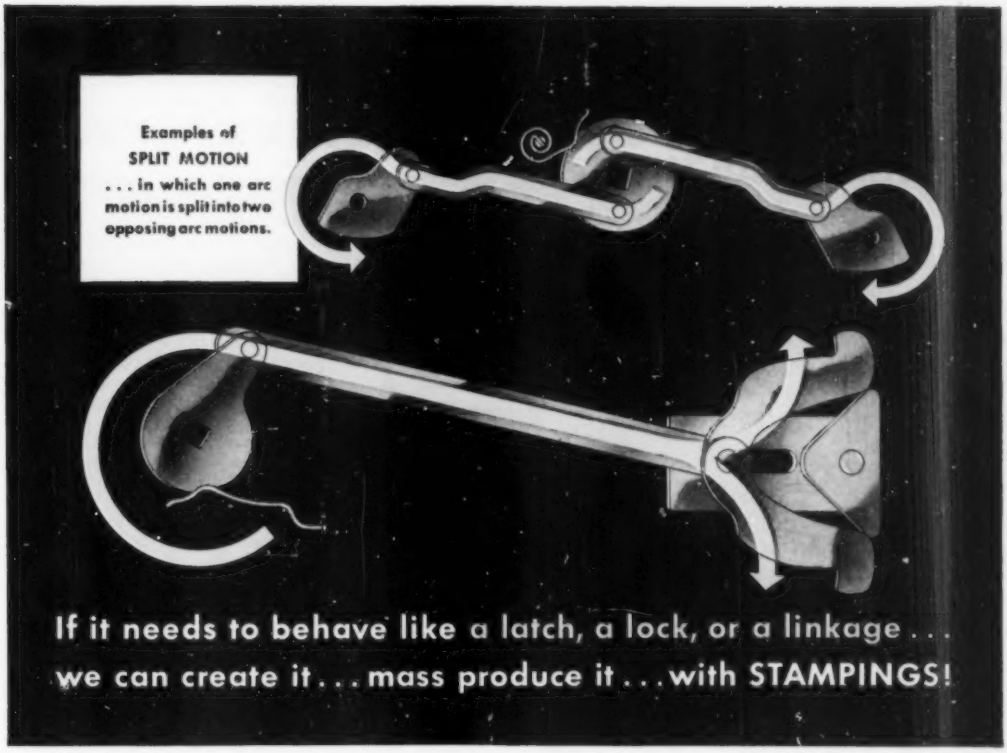
As a first course book, emphasis has been placed on the development of a theory along with its application to practical problems. For this transition, a large number of examples are given which should be useful to the student particularly if he has limited supervision.

This book begins with the elementary stress-strain relationships and discusses the stresses and deflections of various types of beams. In addition to the theory of Torsion there are chapters on Columns and Combined Stress Failures. The final chapters discuss Thick Cylindrical Shells and Castigliano's Theorem.

Raymond Loewy Himself

Never Leave Well Enough Alone by RAYMOND LOEWY. *375 pages with many interesting illustrations. Published by Simon and Schuster, New York, New York. Price* $5.00.

The sub-title of this book, as printed on its jacket, is "The personal record of an industrial designer from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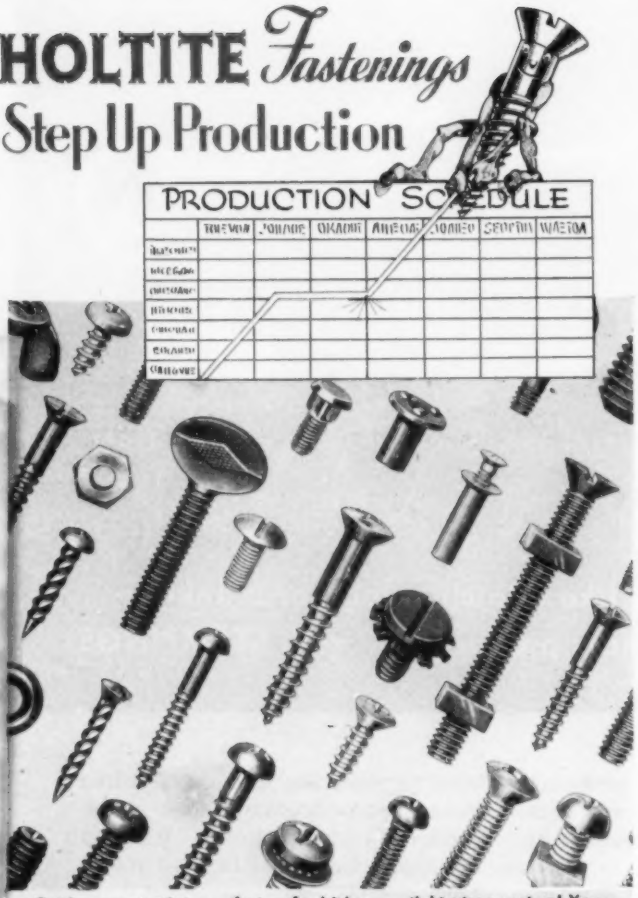

Quick, easy starting . . . fast, safe driving . . . tight, strong set-up! You can depend upon this consistent performance of HOLTITE fastenings to step up production on your assembly line. Substantial time-saving, reduced costs and stronger, vibration-resisting fastenings result from the uniform precision and enduring strength of all HOLTITE products.

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lipsticks to locomotives." Granted that no one could write an eleven word sub-title that would be any better, this is still a terrible understatement. One has merely to read the first five pages to realize that this book is far more than just a personal record. More accurately, it is the record of a personality, besides which it is a most unusual piece of book publishing in that Raymond Loewy not only wrote the manuscript but also selected the type, made the format, designed the cover and jacket and made many of the line drawings that amusingly illustrate some of the points he makes.

The first sample of the humour that crops up repeatedly throughout the book is found in the fourth paragraph of the preface. Raymond Loewy explains how he learned English in his native France from a "paraplegic German teacher and. . . .the American forces during World War I. . . . .who were mostly from Brooklyn", with the result that when he landed in America he knew nothing of the language.

He states in the preface that the book has not been ghost written. For those who know Raymond Loewy even only slightly this statement is superfluous because the book "sounds" exactly like him. Characteristic expressions, sly humour, outspoken criticisms —all the earmarks of the man—convict him of being the author. His page of "acknowledgements" are a masterpiece of humour and subtle sarcasm that leaves the reader chuckling indeed.

The book is divided into three parts. Part I covers his boyhood days in France and his first years in the United States. He relates many highly amusing incidents of his childhood and also describes vividly his emotions as he gazed for the first time on the city of New York from the roof of the Equitable building.

By the time the reader gets to page 75 he begins to feel that he has known Raymond Loewy for quite a few years. And he also begins to realize that the man is more than the country's leading industrial design engineer and an artiste par excellence. Not only does he lack the "long hair" line of talk generally associated with an artist, but he likes and does boxing, fencing and swimming. And of course he mentions martinis now and then. But over and above all that, Mr. Loewy reveals in his autobiography his many human traits, his love of fellowship, his deep understanding of others, his great sense of indebtedness to his associates and to his adopted country.

Part II of *Never Leave Well Enough Alone* deals mostly with Loewy's ca-

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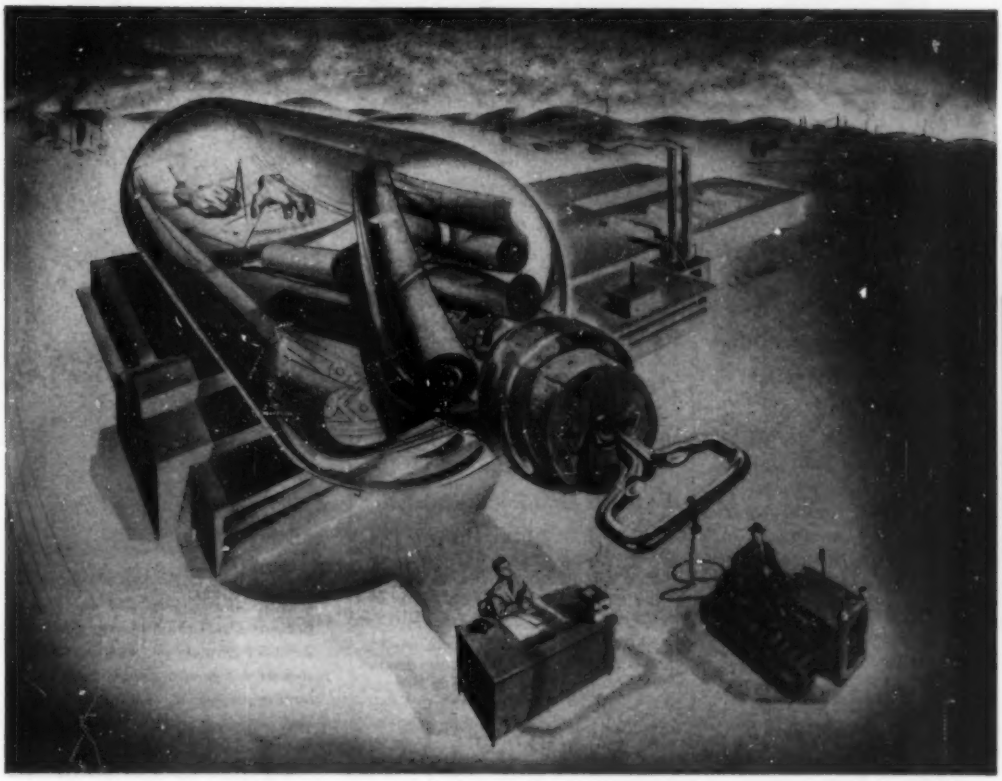

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reer as an industrial designer. Here he tells how he got started by redesigning a duplicating machine. From that beginning he, at first slowly and then rapidly, built his reputation and professional career. But it was not all smooth sailing. The resistance he encountered, the rebuffs he got and his many trials and tributions were sometimes disheartening. Industrialists and engineering executives will find this section, and also Part III, not only interesting but valuable as well.

The final section of Raymond Loewy's story gives his experiences and opinions of good and bad industrial design and also some basic considerations of what constitutes good and bad design. The last three chapters are properly devoted to the work and fun of his day to day living.

So candid and intimate is the whole tone of this book that after reading it one has the feeling that he no longer knows Mr. Loewy but that he now knows Raymond Loewy, the industrial designer, artist, gentleman, humourist and congenial companion, very well indeed.

Technical Drafting Essentials

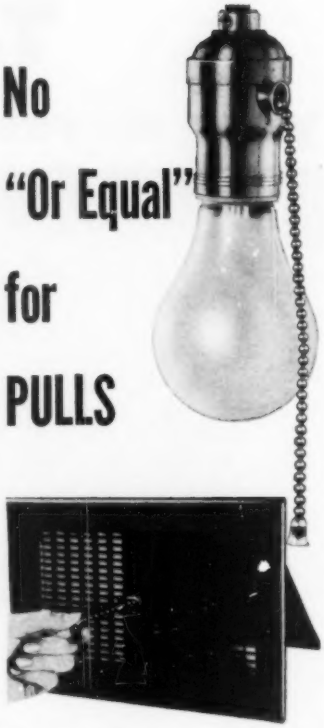
WARREN J. LUZADDER, *Associate Professor of Engineering Drawing, Purdue University. 6 x 9 in. 326 pages. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York, N. Y. $4.*

Directed toward the student in the technical field, this textbook makes use of much of the material in the author's larger "Fundamentals of Engineering Drawing". The objective is to make text as nearly self-teaching as possible. Illustrations accompany each new subject as it is presented and at the end of each chapter there are a group of problems to be worked by the student to help him grasp the content he has just covered.

The opening chapters describe and illustrate drafting instruments, their care and uses. Everything from how to sharpen a pencil to how to form letters is covered. Chapters 6 through 11 introduced orthographic projection, show how to draw sectional and auxiliary views and explain the freehand drawing techniques. Chapter 12 delves into ink work and tracing and brings out the do's and don't's. Chapter 13 gives the general practices in dimensioning. The matter here includes the use of finish marks and other refinements of the art.

With Chapter 14 begins consideration of the more specialized phases such as representation of threads, fasteners, welding, piping, gears and cams. In the section on screw threads

No "Or Equal" for PULLS



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It is strong yet light and attractive. Free-running, even over small sheaves . . . can't kink, bind or jam because every bead is a swivel. Highly adaptable . . . 5 bead sizes, various metals and finishes, and *the widest choice* of attachments for coupling, splicing, hooking, doubling, etc.

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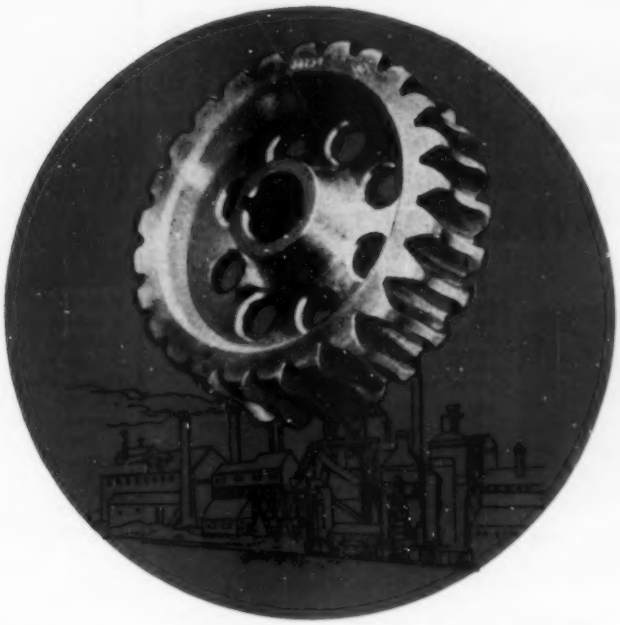
Manufacturers of: **BEAD CHAIN** — the kinkless chain of a thousand uses, for fishing tackle, novelty, plumbing, electrical, jewelry and industrial products; **MULTI-SWAGE** — the most economical method of producing small tubular metal parts for electronic and mechanical applications.



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ONE GEAR THAT LASTS AS LONG AS THREE

Another case that shows how National Bearing Division has reduced operating costs

When any machine makes a habit of breaking down periodically, it's time to take stock of the problem—before production losses and replacement costs skyrocket. That's just what faced a large Midwest steel plant . . . frequent breakdowns of a takeup frame used in coiling wire. The wire, under tension, built up stresses that caused the transmission gears to strip.

National Bearing Division engineers made a special study of this mill's problem. They recommended changing to a bronze alloy known for its ability to retain the anti-frictional qualities of bronze, yet have an unusually high degree of strength.

Result? Not a single gear supplied by National Bearing Division in this alloy has stripped in the last three years! That compares with the former average service of just six months.

Any production man will know that the savings are tremendous, especially over a period of years . . . savings made possible by National Bearing Division metallurgical research on bronze application—*plus the engineering skill to interpret this research in terms of solving an on-the-job problem.*

It's another example showing that we have the facilities, the experience and the *proved* ability to save money for our customers on any problem involving . . .

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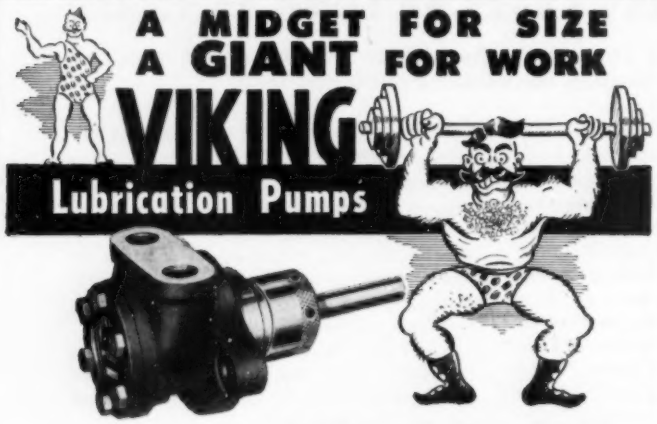

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is presented material concerning the new British-Canadian-American Unified thread form. In this part of the book there is also a long chapter on working drawings that includes numerous problems to familiarize the student with detail drawings, assembly drawings, bills of material and similar matters.

Following the above discussion is a chapter covering isometric, oblique and perspective drawing and their uses. Concluding chapters are devoted to sheet metal drafting, map drafting, structural drafting and architectural drafting. The treatment tends to be sketchy as all of these subjects require much more space for presentation than the author can give them. The appendix contains a number of tables of common engineering information such as dimensions of bolts and nuts.

The Behavior of Engineering Metals

H. W. GILLETT, *Battelle Memorial Institute.* 394 *pages,* 6 x 9½ *in. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York* 16, *N. Y.* $6.50.

There are many books dealing with the details of metallurgy written primarily for metallurgists. This book is not one of these. Its purpose is to help those who are not metallurgists but who participate in the selection of metals and alloys for engineering uses.

The problem of selecting the "right" metal or alloy to fit a given use is no longer a simple matter for the designer. It has become increasingly complex as the number of metallic materials and of methods of preparing them has increased, and as service conditions have become more severe. In selecting an engineering material, the designer no longer depends exclusively on tables of properties in the handbook, but often finds it helpful to consult a specialist—the metallurgical engineer. The specialist, in turn, needs to know the whole story of intended use, sources of supply, fabricating facilities, markets and costs. It often turns out that wise selection of materials involves the sympathetic cooperation of designers, metallurgists, production engineers, purchasing agents and sales engineers.

This book therefore, presents the viewpoint of the metallurgist for those who have not specialized in this field. Since it is intended to help in choosing suitable engineering materials, the behavior of these materials is discussed rather than the

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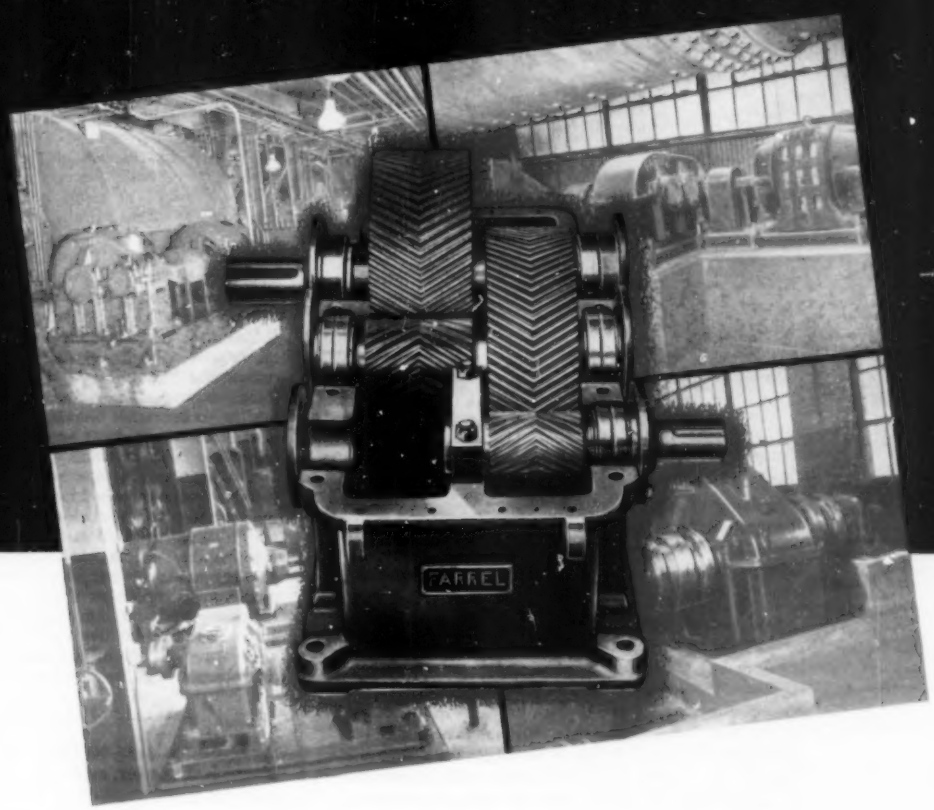
has a special "aptitude" for its job



The design of Farrel speed reducers permits an engineering freedom in proportioning gears, shafts, bearings and even some housing dimensions to meet specific load, speed and service requirements. This flexibility has resulted in the solution of innumerable application problems.

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Shafts and bearings are factored to safeguard against interruption of vital processes. Gear cases are proportioned to withstand repeated heavy peak loads. Joints are sealed to prevent entrance of dirt.

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This automatic control means labor savings, better soldering, current saving, elimination of fire hazard, longer life for soldering irons and operator comfort and safety. Perhaps your product can offer increased benefits through precision control of its performance by Chace Thermostatic Bimetal. Ask the Chace Application Engineer for his suggestions.

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sometimes abstruse theories that seek to explain their behavior. But the non-specialist may properly content himself with the engineering facts that are pertinent to his own work.

Following the same reasoning, technical terms have been used as little as possible, and references have been selected, where a choice existed, for easy reading as well as for technical content. Some facts are intentionally repeated in different chapters, because the same behavior may assume varying degrees of importance depending on the surrounding circumstances.

The first six chapters of the book introduces the basic concepts of metallurgy. Instead of terms being defined by an alphabetically arranged glossary, they are introduced in natural sequence, and examples show how they are used. Thus, the origin of each concept and its relation to others becomes clear.

The next nine chapters deal with the behavior of each of the principal commercial metals and alloys. In these chapters, those materials of greater commercial importance are discussed in more detail than the less commonly used materials.

The remainder of the book is devoted to special considerations that may influence the selection of metals and alloys. These include such topics as machinability; special fabricating techniques; means of using or selecting metals so as to combat the effects of corrosion, wear and high temperature; and some "tricks of the trade." The vital factors of cost and availability are the subject of the closing chapter.

ASTM Standards on Paint, Varnish, Lacquer, and Related Products

Prepared by Committee D-1 on paint, varnish, lacquer, and related products. 690 pages, 6 x 9 in. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $4.85.

This compilation gives the more than 190 specifications, tests, and definitions in their latest form. Specifications, test methods, and chemical analysis of pigments cover: White, black, mineral iron oxide, blue, green, yellow and orange, red, metallic, nonhiding. General test methods for pigments include alkalinity or acidity, bleeding, coarse particles, moisture, oil absorption, gravity, tinting strength and mass color of color pigments, water in petroleum products and other bituminous materials, and pH ofaque-

ous solutions with the glass electrode.

There are specifications, test methods and definitions of terms relating to drying oils, paint driers, thinners, shellac, varnish and varnish materials. Also included as a section on traffic paint, paint weathering tests, and general paint tests. Other standards cover putty, rosin and liquid naval stores. New material in this book includes 24 tests and specifications not published in previous compilations.

ASTM Standards on Adhesives

Sponsored by A.S.T.M. Committee D-14 on Adhesives. 60 pages, 9 x 6 in., paper cover. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $1.25.

This publication contains all 15 A.S.T.M. standards relating to this field. Test methods cover: Resistance of adhesive bonds to chemical reagents; tensile properties of adhesives; applied weight per unit area of dried adhesive solids and liquid adhesive; peel or stripping strength of adhesives; strength properties of adhesives in shear by compression loading and in plywood type construction in shear by tension loading. There are tests for viscosity and total solids content of rubber cement; methods of sampling and testing lattices of natural and synthetic rubbers; also methods of testing rubber adhesives. There is a recommended practice for determining the effect of artificial (carbon-arc type) and natural light on the permanence of adhesives. Also included are definitions of terms relating to adhesives.

New material in this edition includes tests for: Impact strength of adhesives; strength properties of metal-to-metal adhesives in shear by tension loading; and cleavage strength of metal-to-metal adhesives.

Management Reports

Addresses given before the California personnel Management Association and the Personnel Section of the Western Management Association. 8½ x 11 in., 10 to 15 pages. Published by Research Div., California Personnel Management Association, 442 Flood Bldg., 870 Market St., San Francisco, Calif. $1 each.

Management Report 77 by H. M. Doretz, Chief, Division of Wage Statistics, U. S. Dept. of Labor is entitled "Work-Force Effective and Wage

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STEP UP PERFORMANCE of your engine-driven equipment with this rugged, lightweight prime mover. The Onan 10 HP "CK" engine is inherently smooth-running, delivers vibration-free power at all speeds. Alternate-firing, air-cooled. Built for long, heavy-duty service . . . with oversize bearings and rugged construction throughout. Unusually compact, to simplify installation.

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Policy." It deals with problems such as wage differentials relating to the administration of "wages as a tool to secure willing and productive work-effort." For example, wages can be used to direct workers into fields where they are needed.

Management Report 80 is entitled "Improving Worker Performance Through Industrial Relations." The author, A. C. Thorton, Industrial Relations Manager of the International Minerals & Chemical Corp., proposes methods by which industrial relations departments can help develop a good management team of supervisors that can increase worker productivity and heighten worker morale. He says that leadership not driving ability should be advocated.

Management Report 78 is called "Company Experiments in Improving Employee Work-Effort." In this, G. T. Bowden, Personnel Supervisor of the Pacific Telephone & Telegraph Company of Los Angeles, Calif., takes a number of general lessons distilled from the Western Electric Company's experiments at Hawthorne and applies them to common company problems such as worker attitudes toward free enterprise and similar matters.

Symposium on Dynamic Stress Determinations

American Society for Testing Materials. 64 pages, 6 x 9 in. Published by American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. $1.50.

Four technical papers and discussions that were presented at the ASTM Pacific Area National Meeting, San Francisco, October 1949. The symposium presents in a single source pertinent information on the scope, possibilities and limitations of electronic measuring and recording devices.

Following an analysis and interpretation of dynamic records by H. C. Roberts of the University of Illinois, a survey of pickups for dynamic physical measurements is given by G. E. White of Statham Laboratories.

Selection of recording equipment for dynamic testing is covered by K. D. Swartzel of Cornell Aeronautical Laboratory.

Some examples of dynamic testing in the field of structures and materials, with a list of selected references, are noted by D. McHenry and H. E. Hosticka of the U. S. Bureau of Reclamation.

The general title "Dynamic Stress Determinations" is a compromise. It has been interpreted to include the phenomena associated with the dy-

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Announced a few weeks ago as an olive drab finish for zinc plate by the makers of Luster-on Bright Dips, Chemical Corporation's latest conversion coating is exceeding highest expectations. The first batches in the field indicate even better color and film stability.

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KHAKI DRAB is an economical, quick, room-temperature dip for work as it comes from zinc plating line. KHAKI DRAB finish will withstand salt spray corrosion tests of 200 hours. This far exceeds government requirements of 100-hour exposure, so KHAKI DRAB should meet any U. S. Government specification. KHAKI DRAB is an entirely new type of formulation, differs from any drab finish on the market.

Strong Adhesion to Paint

When finished part is to be painted or enamelled, Luster-on KHAKI DRAB gives under-paint corrosion protection, prevents attack at paint breaks or scratches, guards hidden surfaces. KHAKI DRAB is the ideal adhesive base to bond paint to zinc, grips to all types of organic finishes, resists chipping or marring.

Now Released to General Industry

When first announced the new khaki finish was restricted to Government orders. Now Chemical Corporation officials have given nod to full release to include civilian goods (DO's are given preference). Reason given is that new KHAKI DRAB is economical in use of critical materials. Replacing cadmium and nickel with zinc is first economy. This part is now largely required by NPA orders. Second economy is that KHAKI DRAB uses less ingredients in short supply per square foot of work tested than companion Luster-on Bright Dips, Utility-15 and Utility-25.

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Sample parts sent to laboratory will be processed with either Luster-on KHAKI DRAB or Utility Bright Dip and returned without obligation. Technical advice for conversions to Luster-on is available. Address inquiries to The Chemical Corporation, 59 Waltham Avenue, Springfield 9, Mass.

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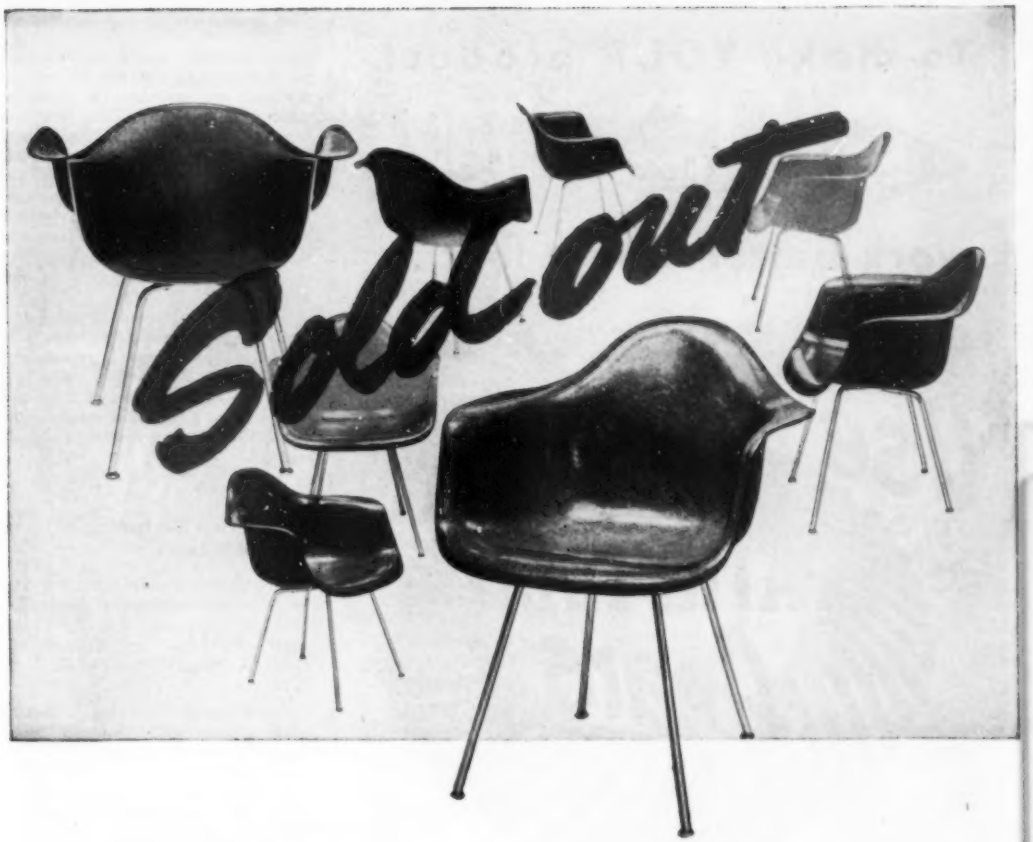

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namic state that would be of principal interest to engineers in the field of materials and structures. In most instances, the phenomenon may be stress, but since stress is a determined quantity and is indirectly obtained from measured strains, deflections, displacements, velocities, and accelerations, specific attention is directed toward such related quantities. The computation of stresses from the quantities measured is not considered in the symposium.

The general problem of making and interpreting dynamic measurements is divided into its elements by considering separately (1) Basic pick-up units, (2) Recording systems operated from the output signal of the pick-up unit, and (3) Analysis and interpretation of such records.

Engineering Mechanics, Third Edition

S. TIMOSHENKO *and* D. H. YOUNG, *Professors of Engineering Mechanics, Stanford University.* 6 x 9 *in.,* 517 *pages. Published by McGraw-Hill Book Co., Inc.,* 330 *W.* 42*nd St., New York, N. Y.* $5.50.

Together with the authors' "Theory of Structures" and "Advanced Dynamics" this book represents in the authors' opinion a fairly complete treatment of engineering mechanics and its applications to problems of modern structures and machines. "Engineering Mechanics" has been set up as the introduction for the undergraduate college student into the field. The chief aim in this third edition has been to improve and to add to the list of problems. The general pattern followed throughout the text is to present each new topic analytically, to work out one or more examples to show its application and then to list a number of problems to be solved by the student.

The book is divided into two parts. Part I, Statics, opens with an introductory chapter bringing out the four principles involved and then goes on to apply them in Chapter II to concurrent forces in a plane, in Chapter III to parallel forces in a plane, in Chapter IV to the general case of forces in a plane, and finally in Chapter V to force systems in space. The concluding chapter in this section introduces the theory of the principle of virtual displacements which the authors feel the student should know because its use results in great simplification in the solution of certain problems of statics.

Part II, Dynamics, is built up on a

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similarly logical plan. However, whereas Part I uses no mathematics beyond the differential calculus, this section requires a knowledge of the integral calculus and differential equations. Chapter VII, the introductory chapter in Part II, sets up the basic dynamic principles, namely, Newton's three laws of motion, and then proceeds into a discussion of rectilinear translation in Chapter VIII, of curvilinear translation in Chapter IX, of rotation of a rigid body about a fixed axis in Chapter X and of plane motion of a rigid body in Chapter XI. The concluding chapter takes up the subject of relative motion. Two appendices are included, one that develops the moments of inertia for a number of the more common plane figures and the other that does the same for material bodies.

Plant Layout Planning And Practice

RANDOLPH W. MALLICK, *executive staff engineer, Westinghouse Electric Corp.; and* ARMAND T. GAUDREAU, *management consultant.* 391 *pages,* 6 x 9½ *in. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $7.50.

In endeavoring to cover the extensive field of plant layout engineering in one volume, the authors have centered their attention on the salient aspects of layout problems encountered in more than 25 years of experience in scores of manufacturing plants.

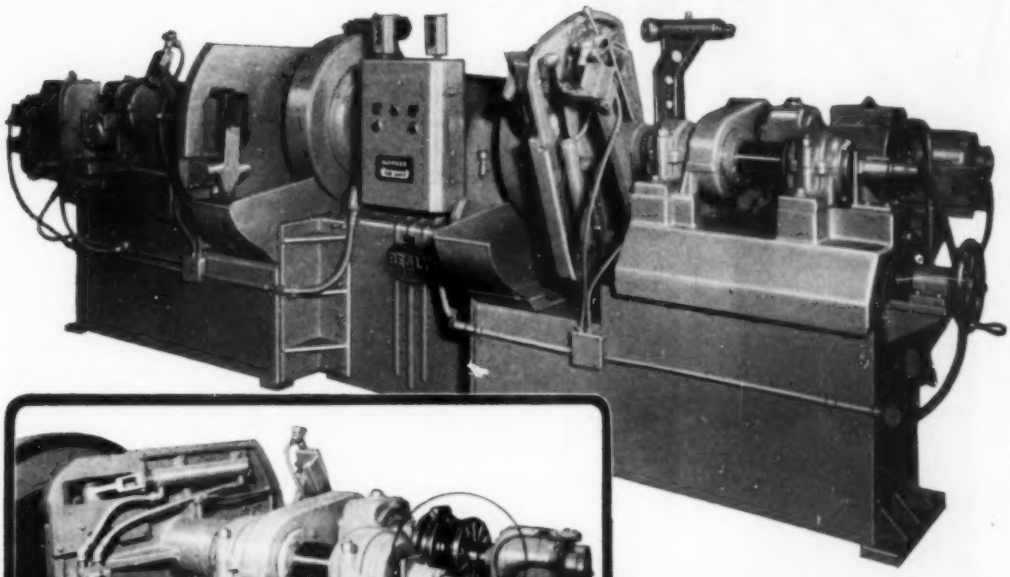
In the preparation of the text, much assistance was received from leading professional engineering companies and from plants forming a cross-section of many important types of industrial enterprise.

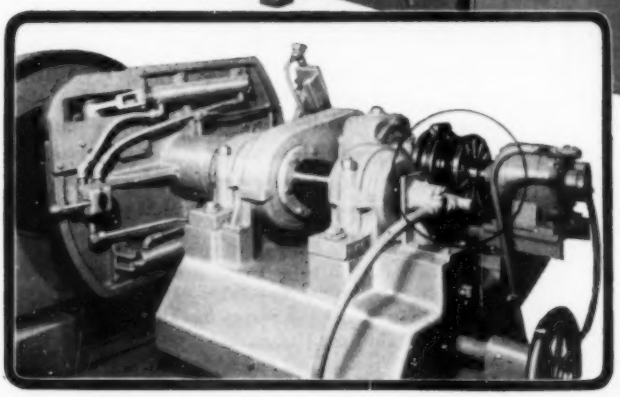
The engineering functions of plant layout discussed by the authors deal primarily with planning rearrangements for existing plants and with designing layouts for new plants. Principles and procedures are set forth for determining plant capacities, balancing machine operations, and equipping work stations.

Techniques are presented for designing production and assembly lines; receiving, shipping, and storage areas; dispatch stations and tool rooms; material handling systems; and service facilities and office space.

Methods are discussed for evaluating capital outlays for plant and equipment; operating costs and projected savings; and the preparation of proposals for presentation to management.

FREE HAND GRINDING ELIMINATED on heavy journal bearings with WARNER ICB equipped Besly Grinder





Full view of Besly special two-station grinder for facing off bronze journal bearings. Machine incorporates two Warner ICB combination electric clutch and brake units. (See close-up). Machine completes three bearings per minute, eliminates human error of hand grinding, assures uniformity. ICB units start, stop and position work pieces at each work-holding station.

WARNER ICB units offer a wide variety of design possibilities in the control and operation of nearly all types of machinery. Simple in construction, they occupy little space. Operated electrically, they provide instant, smooth response. Already being used on many different kinds of machinery to simplify control, eliminate complicated mechanical drives, increase production, provide greater safety and reduce maintenance, WARNER ICB units are available in several sizes, as single clutch or brake units, or in combination. Write today for complete information. Our engineers will consult with you, at no obligation. WARNER ELECTRIC BRAKE & CLUTCH CO., Beloit, Wisconsin. Dept. PE.

WARNER
ICB UNIT

WARNER ICB Units are manufactured by Warner Electric Brake Mfg. Co. — pioneers in the field of electric brake design and application since 1927.

The chemists could tell you a thing or two about Stainless Steel

YOU don't have to be connected with the process industries to know that many details of chemical processing are vital and closely-held secrets. But it's no secret that a very large share of this production, whether hush-hush or not, is conducted in equipment made of stainless steel—for the excellent reason that stainless steel is the *one* material that best meets the need for great strength and high resistance to corrosion, heat and wear.

Put it this way: Allegheny Metal equipment gets the call because stainless steel lasts longer, looks better, cleans easier and quicker, maintains top purity standards and holds maintenance and depreciation costs down to the bottom.

That's why Allegheny Metal is a highly essential material, especially in time of national need. We've spent (and are spending) many millions of dollars to increase our production, but it is still necessary to make every ton of stainless steel go as far as possible. ● Let our engineers help you *to use* Allegheny Metal and other alloy steels to the best advantage.

* * * * *

Complete technical and fabricating data—engineering help, too—are yours for the asking from Allegheny Ludlum, the nation's leading producer of stainless steel in all forms. Branch Offices are located in principal cities, coast to coast, and Warehouse Stocks of Allegheny Stainless Steel are carried by all Joseph T. Ryerson & Son, Inc. plants. ● *For any assistance, write or call* Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Penna.

WAD 3268

You can make it **BETTER** with

Allegheny Metal

AL TIME-TESTED STAINLESS STEEL

Announcing

Kodagraph Autopositive Paper Translucent

a new photographic intermediate material that speeds up print-making . . . drafting

30% *more translucent* than "regular" Autopositive —for faster quantity-print production

Here is a new type of Kodagraph Autopositive Paper . . . especially designed to give you increased speed in large-volume print production.

Like "regular" Autopositive, *Kodagraph Autopositive Paper, Translucent* can be handled in room light . . . prints directly to a positive in familiar reproduction equipment . . . is processed in standard photographic solutions. It reproduces original detail sharply, crisply . . . and its dense black photographic lines will not fade, smudge, or wear off.

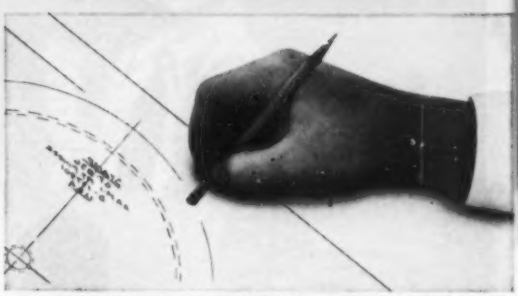
But this new paper has an important "extra" which you'll spot at first glance—*an entirely new base* . . . remarkably translucent . . . remarkably durable.

Its 30% extra translucency enables you to turn out sparkling blueprints or direct-process prints faster, which lowers production costs considerably in large-volume work. *And it makes practical and convenient* the general use of "reverse-reading" intermediates (which assure final prints of top quality).

Its extra durability simplifies the handling of larger-size sheets . . . offers increased resistance to wear and tear in print-making and drafting.

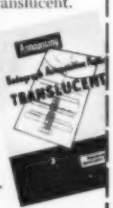
***So translucent* . . . you can easily read details on opposite side**

Reverse-reading intermediates, while better for print-making, used to be a problem in the drafting room. But no longer! Now the draftsman simply turns this highly translucent paper over . . . reads through the back—sees every detail sharp and clear. Additions, when necessary, are also made on this side.



Another drafting "PLUS." Unwanted detail can be removed from an Autopositive Translucent print in seconds with an ordinary eraser, without appreciable effect on the base, when the area involved is moistened slightly.

MAIL COUPON TODAY . . . for full details on Kodagraph Autopositive Paper, Translucent. Intermediates on this new paper (which you or your commercial blueprinter can make) may well prove the key to important savings in your drawing reproduction operations.



EASTMAN KODAK COMPANY, INDUSTRIAL PHOTOGRAPHIC DIVISION 15
ROCHESTER 4, N. Y.

Gentlemen: Please send me a copy of your new free folder describing Kodagraph Autopositive Paper, *Translucent*.

Name_____ Position_____

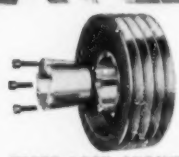
Company_____

Street_____

City_____ State_____

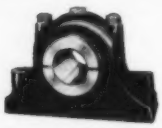
Kodak
TRADE-MARK

IF IT'S DODGE
-IT'S
DEPENDABLE!

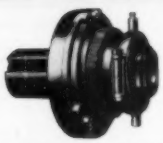


TAPER-LOCK SHEAVES: Patented Taper-Lock is the world's simplest mechanism for mounting wheels to shafts. Easy on—easy off! 476 stock sizes in A, B, C and D grooves.

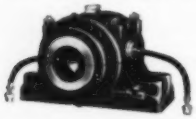
TORQUE-ARM SPEED REDUCERS: America's most complete line of shaft mounted speed reducers. Capacities from 1 to 27 h.p. Output speeds from 12 to 330 r.p.m.



DODGE-TIMKEN BEARINGS: Mounted units, proved in millions of industry's toughest jobs. The famous 30,000-hour line. Four types to choose from. Sizes from 1-3/16" to 8".



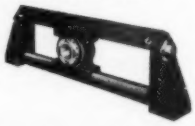
ROLLING GRIP FRICTION CLUTCHES: No toggles! Compact, flexible, smooth and DEPENDABLE. Bolted plate and gear tooth plate. 1.3 to 21.2 h.p. at 100 r.p.m.



SLEEVOIL BEARINGS: Precision built, exceptionally quiet, thoroughly dependable. "Tops" for fan and blower service. Sizes 1-7/16" to 8" in both plain and water cooled types.

SOLID STEEL CONVEYOR PULLEYS: Maximum strength, minimum weight. *Modern* pulleys with interchangeable hubs that cut installation cost. Diameters 6" to 8'. All face widths.

DODGE SEALED-LIFE V-BELTS: Special protection for tension members insures longer belt life. Perfectly matched to Taper-Lock sheaves for best performance.



DODGE TAKE-UPS: Modern, rugged, dependable. Roller bearing (illustrated), ball bearing and babbitted. Shaft sizes from 3/4" to 4". Travel from 4" to 36".

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NOTED THROUGHOUT THE WORLD FOR HIGH QUALITY, PRECISION MANUFACTURE

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MANUFACTURERS OF A BROAD LINE OF MECHANICAL POWER TRANSMISSION MACHINERY

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ORIGINATORS OF NEW AND BETTER PRODUCTS FOR THE MECHANICAL TRANSMISSION OF POWER

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USED CONFIDENTLY WHERE THE GOING IS TOUGHEST

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CALL THE TRANSMISSIONEER: Most Dodge products are normally available from distributors' stocks — in your territory — when you need them. For information on the newest and best methods of mechanical power transmission, call the Dodge Transmissioneer, graduate of the Dodge factory course. He is your local Dodge Distributor. Look for his name under "Power Transmission Equipment" in your local classified telephone directory.

PILLOW BLOCKS: Roller Bearing, Ball Bearing, Babbitted. **FLANGE BEARINGS:** Roller, Ball, Babbitted. **HANGER BEARINGS:** Roller, Ball, Babbitted. **TAKE-UPS:** Roller Bearing, Ball Bearing, Babbitted. **BASE PLATES. FLOOR STANDS. DROP HANGERS. V-BELT SHEAVES:** Both TAPER-LOCK and Bored-to-Shaft-Size. **BELTS:** Industrial and FHP V-Belts and Flex-Link Belting. **SPEED REDUCERS:** TORQUE-ARM Shaft Mounted Speed Reducers. **CLUTCHES, FRICTION:** Rolling Grip, Diamond D and Solid Types. **COUPLINGS:** TAPER-LOCK Flexible, TAPER-LOCK Rigid and Flange Types. **SAFETY SET COLLARS. PULLEYS:** Steel Split Transmission and Solid Steel Conveyor Pulleys. Rubber Lagging. **VISES:** SLIDE-SET Machinist's...FOR COMPLETE LINE, TYPES AND SIZES, WRITE FOR BULLETINS AND 224-PAGE CATALOG.

DODGE

of Mishawaka, Ind.

"First in Power Transmission Machinery!"

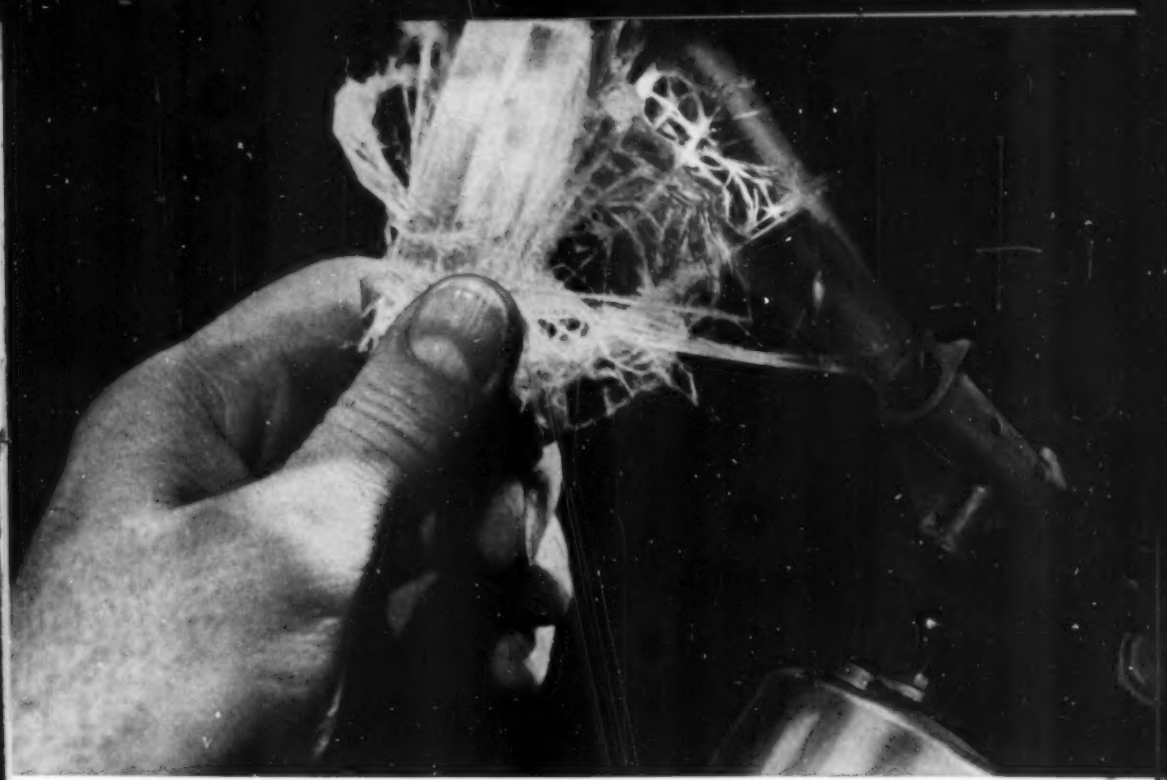
at the **Raymond**

Manufacturing Co.

Division of Associated Spring Corp.

Corry, Pennsylvania

SPRINGS • WIRE FORMS • SMALL STAMPINGS



ASBESTOS CANNOT CARBONIZE—IT ENDURES FOREVER

AVOID THIS!

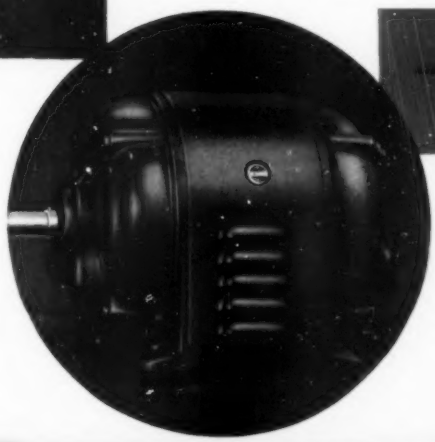
U. S. MOTORS

are asbestos-protected

Life of a motor is proportional to the life of the insulation protecting its windings. While there is no way to guarantee perpetual life, there *is* a method of insulating the windings so that life will be infinitely increased—by using *asbestos insulation*. That is the proved element used in insulating the windings in U. S. Motors. Asbestos is the greatest of all pliable, heat-resisting materials.

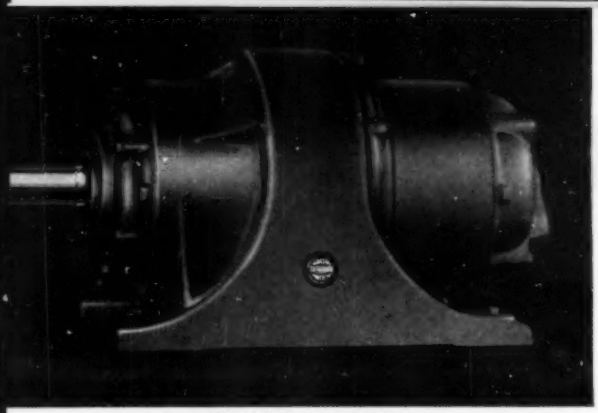
U. S. WINDINGS MOST RESISTANT TO HEAT

A burnt-out motor is evidence that the windings have failed. Commonly used cellulose materials can carbonize, changing from insulator to conductor, whereas asbestos is a fibrous rock whose silken fibres can turn red hot but *cannot carbonize*. U. S. windings are forever protected.

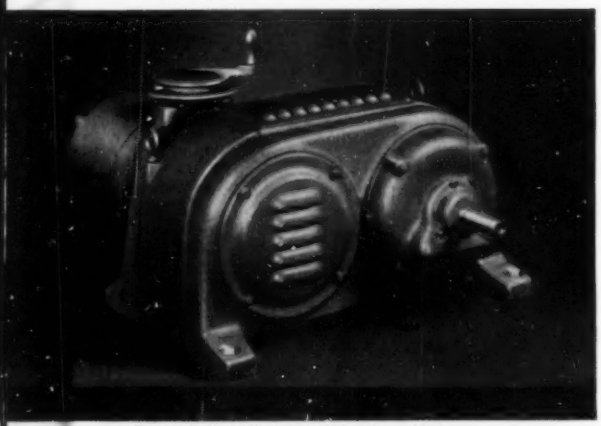


(A)—Empty stator slot before insulating and winding. (B)—Formed cell of asbestos providing a heat-proof wall of insulation. (C)—Cross section showing wires inserted, with asbestos cell covering entire winding. Asbestos plateboard in center of slot separating and insulating between coils. (D)—Asbestosite (in color) forced around windings, penetrates every interstice.

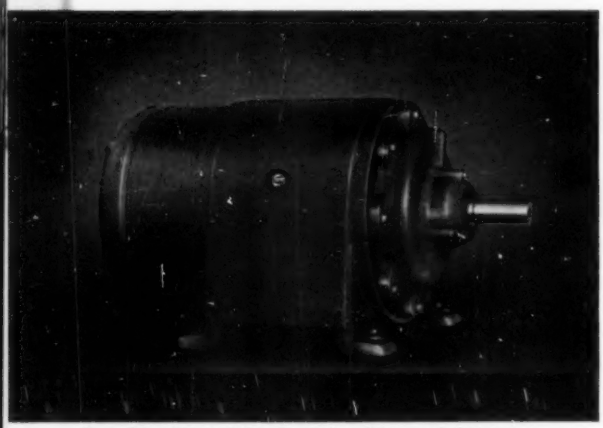
(See next page)



Type GD, U. S. Syncrogear Motor



Type VE, U. S. Horizontal Varidrive Motor



Type SE or SD, U. S. Totally-Enclosed Fan-cooled Motor

U. S. MOTORS

offer these advanced features:

ASBESTOS-PROTECTED WINDINGS
NORMALIZED CASTINGS
ANNEALED STEEL LAMINATIONS
SOLID CENTRICAST ROTORS
DUAL CYCLONE VENTILATION
LUBRIFLUSH LUBRICATION
STREAMLINED, SHIELDED HOUSINGS

Since the inception of U. S. Motors in 1908, a highly successful principle has been maintained—*to build up to a quality*, not down to a price. You can sense U. S. quality in the appearance of these motors. But even more impressive are the many advanced features that insure longest life.

Every U. S. Motor is asbestos-protected—because asbestos *cannot* carbonize. This is an exclusive U. S. feature. By normalizing castings, bearing alignment is maintained so that destructive stresses cannot occur. Lubriflush lubrication presents a convenient means of purging the bearings of old, worn-out grease and replacing the entire bearing chamber with new lubricant without disturbing the bearing setting. The bearings are also self-lubricated for normal life so that even if the old grease is never replaced, bearings are protected.

YOU'LL FIND LOTS OF INTEREST IN THIS BULLETIN

—showing 15 latest types of U. S. Motors

All types of U. S. Motors reproduced from natural color photos are included, to give you a clear conception of the extensive line available. Write for Bulletin 1543. Mention type of motor you desire and Bulletin featuring that type of motor will also be sent.

U.S. ELECTRICAL MOTORS Inc.

PACIFIC PLANT: Los Angeles 54, California **ATLANTIC PLANT: Milford, Connecticut**

Atlanta 3, Ga.; Bakersfield, Calif.; Boston 16, Mass.; Chicago 8, Ill., Cincinnati 16, Ohio; Cleveland 14, Ohio; Dallas 9, Texas; Detroit 2, Mich.; Fresno 1, Calif.; Houston 4, Texas; Indianapolis 4, Ind.; Milwaukee 2, Wisc.; Minneapolis 2, Minn.; New York City 6, N. Y.; Philadelphia 2, Pa.; Pittsburgh 2, Pa.; San Francisco 7, Calif.; Seattle 4, Wash. » » » » *Distributors and Agents in all principal cities.*

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YOU NEED THE PROTECTION OF

WIREBOUND BOXES and CRATES

Losses due to container failure have no place in an industrial economy facing material allocations and shortages. That's why you should investigate *Wirebounds* —which combine the strength of steel with thinner wood to bring you *better product protection at lower cost.* Three hundred graduate engineers of the Wirebound Institute have been technically trained to design tailor-made *Wirebounds* which assure damage-free product delivery. The value of this container engineering is clearly demonstrated in the following case histories. We will be glad to show you how these benefits apply to *your* product. Use the coupon below.

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Flexible power saw maker reduced shipping weight from 820 to 775 pounds, cut crating time 30%. Company stacks and handles units four high. Shipping damage due to container failure has been completely eliminated.

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BOXES & CRATES

☐ Send me general information . . . complete descriptive book titled "What to Expect from Wirebounds."

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☐ Give me direct action send an Institute trained sales engineer to show the advantages of Wirebound packing for my own product

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OUR PRODUCT IS _____ IT WEIGHS _____

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Engineered Rubber

THE GENERAL TIRE

Mechanical Goods

General has invested millions in the finest laboratories, machinery and plants devoted to the development and application of rubber and plastic materials in modern industrial design. The service of General's large staff of the world's finest chemists and engineers are at your service, ready to work with you in the development and testing of rubber and plastic parts to solve your specific product problem. Inquiries are invited. No obligation.

RUBBER TORSIONAL SPRING

Rubber parts are assembled with compression and work in compression so that there is no fatigue limit.

- Simple to apply
- Snubbing action for overloads
- Damping action for shock loads and resonance
- No lubrication or maintenance
- Simple to replace.

Numerous Applications

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- Motor cars, all army vehicles, agricultural vehicles
- Airplane landing gears
- Buses, trolley buses, electromobiles
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- Elastic couplings, pulleys, transmission shafts
- Cable suspensions

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and Plastics for Advance Designing

and RUBBER COMPANY

Division, Wabash, Indiana

THE GENERAL TIRE

SILENTBLOC MOUNTINGS, BUSHINGS, BEARINGS

Union of concentric metal cylinders joined by a layer of rubber under pressure for vibration control

MOLDED RUBBER PARTS

in any size, shape and type of rubber, hard or soft, solid or hollow, accurately made

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Shape themselves to difficult contours. Cushion window glass against breakage and rattling. Make a weather-proof job

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In any solid or hollow shape. Non-staining, no-odor refrigerator door gaskets are typical

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For lubricant and hydraulic applications

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VITAL RUBBER and PLASTIC PARTS for

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- **ELECTRICAL**
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Engineered Plastics for Advance Designing

Cellular Polyvinyl Chloride

AS APPLIED TO GUN TURRETS

Thermal insulating liner with a K factor as low as 0.249. Shock cushion for personnel. Fire resistant. Easy to apply with cement to compound curved surfaces.

Cellular Polyvinyl Chloride has OUTSTANDING FLOTATION QUALITIES

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with New Advantages for a Multitude of Applications

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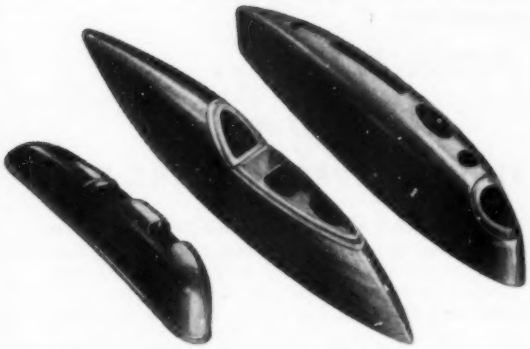
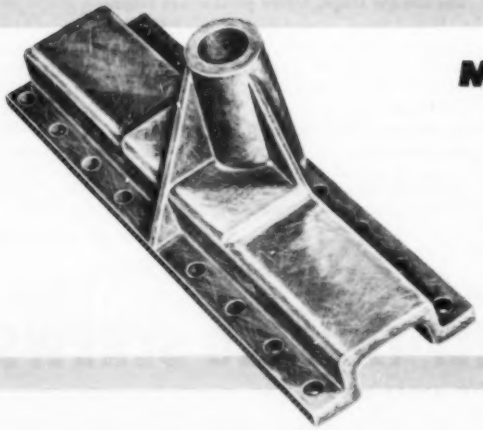
Converts any wallboard, paper, cardboard or similar material to structural strength. Weather and fire resistant. Moisture proof. Available in any color. Washable. No painting necessary. Send for sample.



Eldred Process Applications

Exclusive reinforced plastic process that makes small quantity of complicated parts and large sections available at low cost.

Ideal for mock-ups of automobiles, boats, pontoons, aircraft parts, housings, cabinets and any other shapes with compound curves.



Molded Plastic Parts

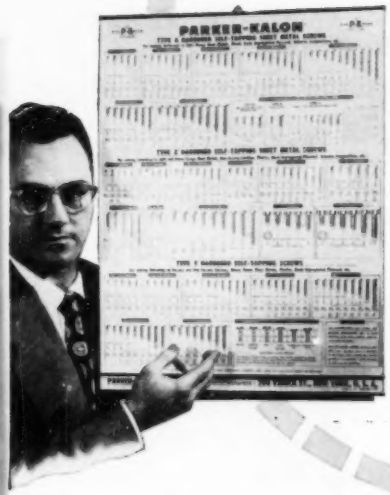
Ideal as replacement material for metal castings or fabricated parts. Lighter than any metal.

General molded plastics have same strength-weight ratio as aluminum. Can be molded in any shape; drilled for a sequence of large or small holes. Especially applicable where specialized physical, electrical and chemical properties are needed.

Mechanical Goods Division, Wabash, Indiana · Washington, D. C. (1625 I Street N. W.)

2. *P-K'S SELF-TAPPING SCREW BULLETIN*
Explains the "why, where and when" of using Self-tapping Screws; 48 pages, in all, of complete descriptions, of valuable application information, including case histories showing how other manufacturers licked assembly problems similar to yours.

3. *P-K ENGINEERING STANDARDS*
A 48-page bulletin giving standard head and thread dimensions of P-K Screws, plating finishes, and other useful data. Clear, complete—prized by designers and draftsmen.



1. *THE NEW P-K SCREW SIZE CHART*
Illustrates in actual sizes standard P-K Self-tapping Screws and other fasteners in the P-K line—makes it easy for you to select the proper size—to avoid errors, returns and exchanges.

P-K saves you time before you start production . . .

of many HERE ARE THREE REASONS WHY

The time-saving P-K* Screws effect in assembly is well-known. By using them, you can skip tapping, avoid inserts in plastics, and work much faster than with bolts, rivets, and other common fasteners.

But P-K saves you a lot of time, too, in selecting and specifying Self-tapping Screws from the multiplicity of types, sizes, and head styles, while the job is still in the design stage, *before* production begins.

Simplifying your job of digging for data is a continuing project at P-K. P-K service literature is recognized throughout industry to be exceptionally clear, concise, and keyed exactly to assembly planners' needs.

It will help you more than ever today, when your operations must be adjusted to limited supplies. Remember, too, that P-K Assembly Engineers are ready to apply an unequaled experience to your most difficult problems of planning and procurement. Parker-Kalon Corporation, 200 Varick Street, New York 14.

*TRADE MARKS REG. U.S. PAT. OFF.

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The Original

PARKER-KALON* SELF-TAPPING SCREWS

A TYPE AND SIZE FOR EVERY METAL AND PLASTIC ASSEMBLY

Take a "BIG BITE" out of Product Costs

Put teeth in your power drives with DAYTON COG-BELTS *T. M.

★ DELIVER 40% MORE H.P. ★ SAVE UP TO 28% DRIVE WEIGHT ★ SAVE UP TO 47% DRIVE SPACE

Patented premium Dayton Cog-Belts with rayon cords, actually improve performance of your product, while *lowering* its cost!

They deliver 40% more horsepower than ordinary V-Belts of the same cross-section size. On a 40 H.P. C-section drive you save the cost of two belts, four pulley grooves, as 5 Cog-Belts do the job of 7 ordinary belts. This drive weighs 28% less, takes up 47.2% less space than an ordinary V-drive. You save on shipping, handling, warehousing your product.

You save, too, because your product *keeps* sold and trouble-free. Cog-Belts are built to bend (like the joints of your finger). They stand flexing strains, starting and shock loads better, last years longer. To add these premium features to your product, write for latest engineering data on the Cog-Belt.

DAYTON RUBBER COMPANY, DAYTON 1, OHIO

V-Belts by Dayton Rubber

WORLD'S LARGEST MANUFACTURER OF V-BELTS

Square D MOTOR STARTERS

Square D's **design leadership** is reflected in important features, many of which were developed specifically to meet the requirements of the machine tool industry.

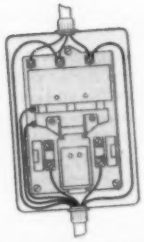
Generous wiring space . . . simple contact change . . . quick coil removal . . . additional electrical interlocks . . . long life . . . NEMA standardization . . . simplified maintenance. These are features which put Square D on the preferred list of many of the country's outstanding machine tool builders.

SQUARE D COMPANY

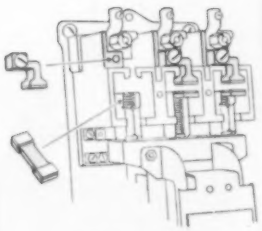
DETROIT · MILWAUKEE · LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

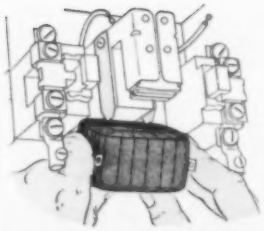
—an example of DESIGN LEADERSHIP



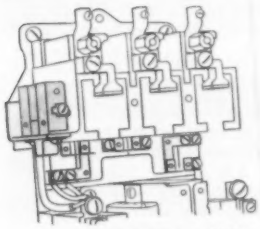
1) EASY TO WIRE—Compact starter design provides generous wiring space with minimum box size. Either pressure wire connectors or solderless lugs permit leads to be attached quickly and securely.



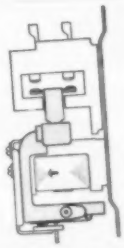
2) SIMPLE CONTACT CHANGE—Removal of arc chamber cover exposes all contact surfaces. Two-piece stationary contact allows replacement without disturbing wiring.



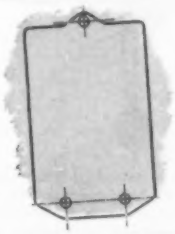
3) QUICK COIL REMOVAL—Coil readily accessible by removing arc chamber cover and lifting off armature assembly. Screwdriver only tool required.



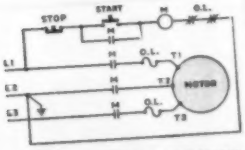
4) ADDITIONAL ELECTRICAL INTERLOCKS—Wide variety of available combinations adds flexibility to starter use in special applications.



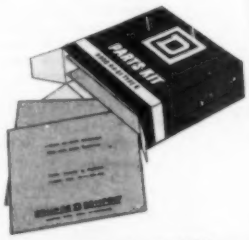
5) LONG LIFE—Straight line, guided motion of armature and movable contact assembly eliminates bearing, simplifies construction, reduces wear.



6) NEMA STANDARDIZED MOUNTING—Base plates of Size 0, 1 and 2 starters have NEMA standard mounting holes but are also interchangeable with previous designs.



7) NEMA STANDARDIZED WIRING provides added safety, permits standardized diagrams and simplifies interchangeability of equipment.



8) PACKAGED PARTS—clearly identified, simplify normal maintenance and minimize replacement part ordering and stocking problems.

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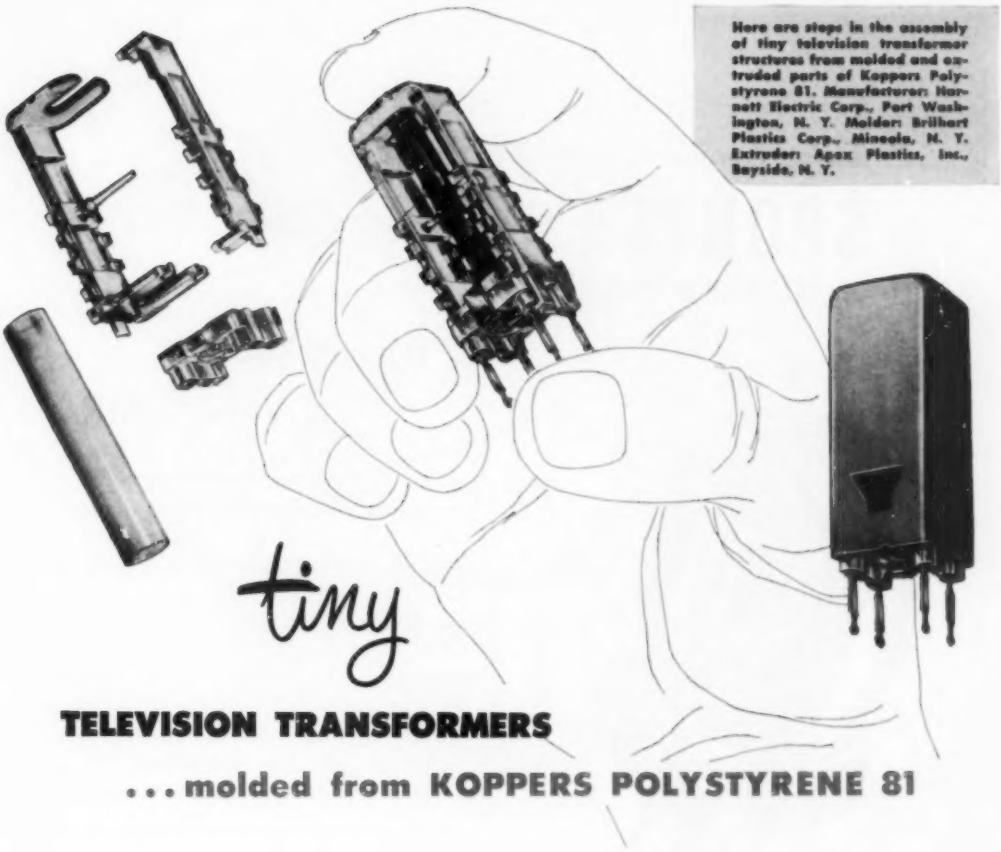

Here are steps in the assembly of tiny television transformer structures from molded and extruded parts of Koppers Polystyrene 81. Manufacturer: Harnett Electric Corp., Port Washington, N. Y. Molder: Brilhart Plastics Corp., Mineola, N. Y. Extruder: Apex Plastics, Inc., Bayside, N. Y.

tiny

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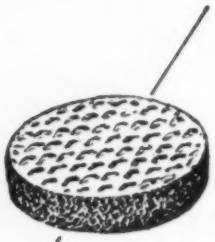

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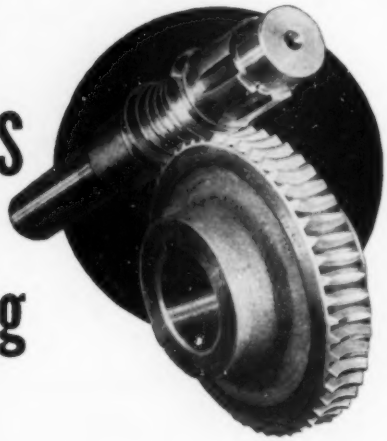
CONE-DRIVE GEARS are true DOUBLE-enveloping



What CONE-DRIVE double-enveloping gears mean to the user

1. Greater Load Carrying Capacity, since
- ALL engaged teeth are in CONTINUOUS CONTACT
- EACH tooth is in contact FULL DEPTH and for a substantial portion of its width

2. Smaller Gears Can Be Used, since
- Load carrying capacity is greater
- Strength is higher
- Unit pressures are lower

3. Gears Are Stronger, since
- Load is distributed over all teeth in engagement
- Teeth are in "shear" only
- Tooth thickness can be varied between a gear and pinion of different materials to balance stresses

4. Gear Design Is Simplified, since
- Ratio, number and size of teeth do not affect capacity or tooth strength
- Pressure angle is fixed, circular pitch does not have to be considered

5. "Hydraulically-smooth" Drive Is Obtained, since
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- Regardless of the number of teeth in the gear, a full ⅛ of the teeth are simultaneously in contact

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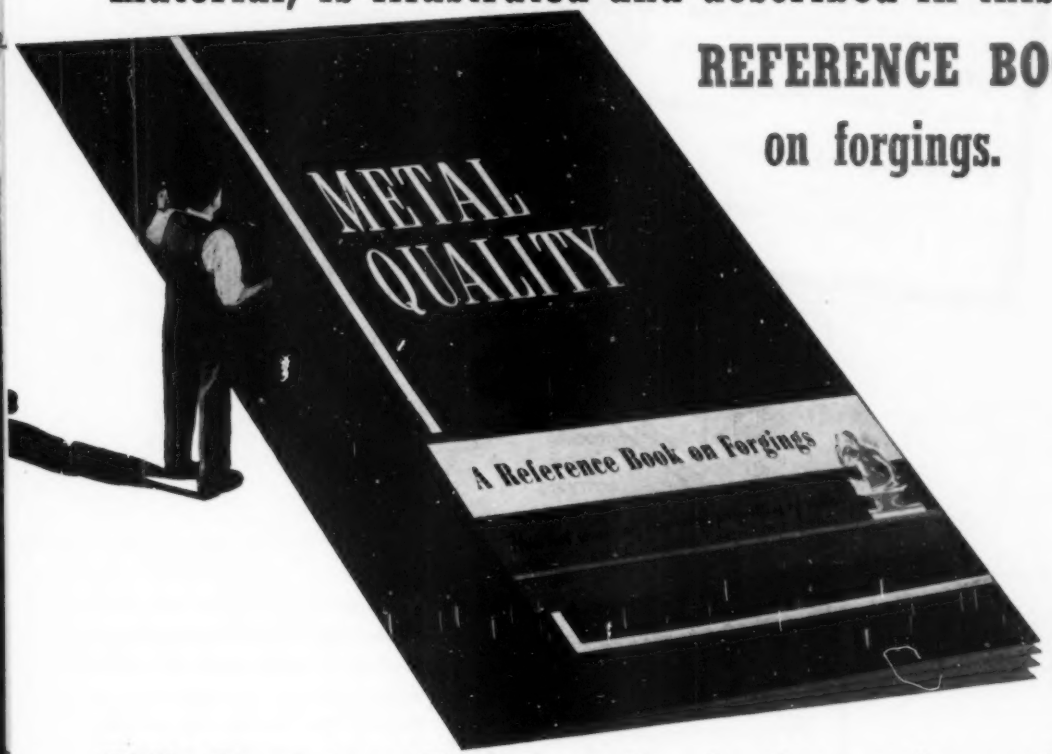

Write for a copy. Then consult a forging engineer about how you can obtain the correct combination of mechanical qualities in forgings for your particular type of equipment.

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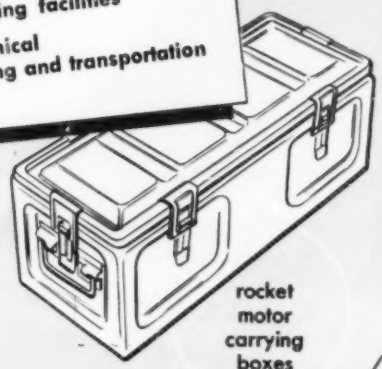

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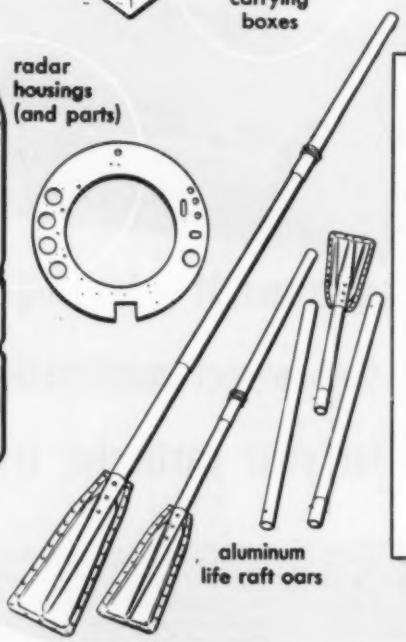

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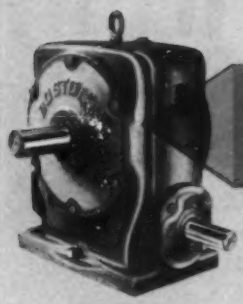

BOSTON REDUCTOR

BOSTON RATIOMOTOR

To the naked eye, one power transmission unit may look just like another — so why not buy the one that costs a bit less? The answer, as many have learned from bitter experience, is that the difference in operating and replacement cost (the unforeseen or "hidden" expense) far exceeds the difference in purchase price.

Take the Case of the Production Welding Machine

A large unit was designed around a low priced speed reducer that gave out in a few weeks and had to be replaced by a BOSTON Reductor. Here is the cost picture:

Net difference in first cost	+ $ 10.00
Cost of repairing machine and replacing gear unit (2 men, 5 hrs. @ $3.00 per hr.)	— 30.00
Loss of production (5 hrs., 12 parts per hr. @ $24.00 per part)	— 1,440.00
NET LOSS	$1,459.00

Take the Case of the Baking Oven

A cut price horizontal speed reducer failed and was replaced by a BOSTON Ratiomotor.

Net difference in cost	+ $ 10.40
Cost of overhauling oven and installing new unit (3 men, 4 hrs. @ $2.00 per hr.)	— 24.00
An entire batch of pastry worth $30.00 was lost due to drive breakdown. This, plus production time (4 hrs., 12 batches per hour @ $20.00 per batch) made a total loss of	— 960.00
NET LOSS	$993.40

The *hidden quality* in BOSTON Reductors and Ratiomotors is very real, even if you don't detect it at first glance. It is the result of BOSTON *Gear's* strict materials control, master craftsmanship and rigid inspection system. This *hidden quality* plus the unequalled convenience and service obtainable from Authorized Boston Gear Distributors (*see adjacent list*) makes it true and lasting economy to:

Specify Standardized Boston Reductors and Ratiomotors

Design Them Into Your Equipment

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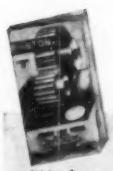

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Miter Gears

Bost-Bronz | Couplings | Universal Joints | Pillow Blocks | Sprockets and Chains | Bearings | Worm Gears | Helical Gears | Bevel Gears | Spur Gears

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Multi-Purpose Thermostat helps solve heat-control problem in Bede Paint Heater

BEDE PAINT HEATERS, used to speed up paint spraying and save material by heating both paint and air, rely on Fenwal Block Head THERMOSWITCH Unit installed in explosion-proof heating block.

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LOW-COST SOLUTION

A Fenwal THERMOSWITCH Unit — 8/10 of an inch in diameter — met all specifications: low cost, precise performance, compact size, high current-carrying capacity. By this, it enables Bede Paint Heaters to lower the cost of paint spraying throughout industry.

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Many types of control problems can be solved by easy-to-install, easy-to-maintain Fenwal THERMOSWITCH thermostats. Their activating control element is the single-metal shell that expands or contracts *instantaneously* with temperature changes, making or breaking the totally enclosed electrical contacts. Through this unique principle, THERMOSWITCH Units effectively control *many* variables where heat is a factor.

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The Precision, Multi-Purpose, Thermostat Control

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OTHER (Please fill in your special requirements) .....

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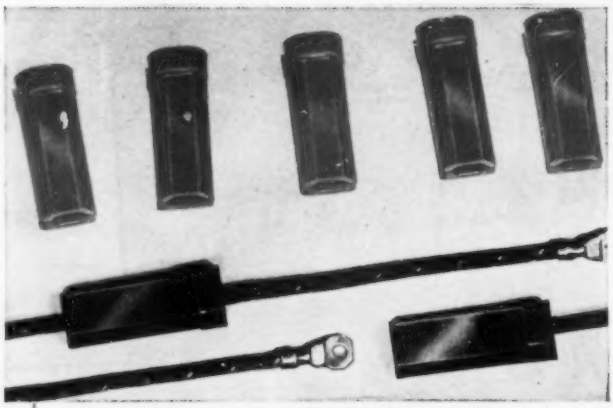
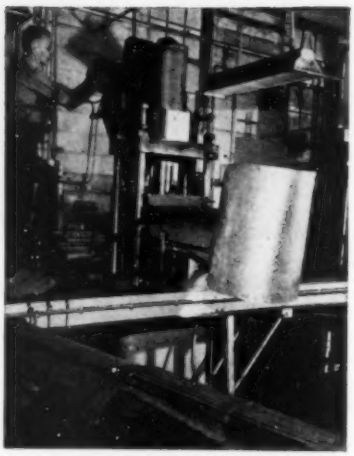
Design for Automatic Molding

...cut labor
...cut costs
...cut investment



Plastic Insulators for electrical connections, shown in connected and disconnected positions, used in quantities for lighting and other connections on automobiles . . . made by Wade on Stokes Presses.



One of the Stokes 741 fully automatic molding presses at Wade Electric Products Company, Sturgis, Michigan. Parts drop on conveyor belt, thence to tumbler. Occasional filling of hopper is the only regular attention required.

Each unit in this installation of Stokes 741 automatic molding presses produces approximately 40,000 parts per hour which are automatically conveyed to a tumbler to remove flash.

The part is an insulator for an electrical connector, small but complex, previously considered impossible to produce automatically.

The Stokes 741 fully automatic molding press assures high production of perfect, uniform parts, and takes the place of a large plunger press with its preform press, electronic preheater, and the full-time and part-time operators required to run it.

In automatic operation one man periodically fills the hoppers with molding powder and removes the finished parts; otherwise no attention is needed.

Let Stokes experts judge from parts or blueprints if your products qualify—or can easily be re-designed for—the high production and large savings per unit which are possible by automatic molding. Or send for a 24-page brochure on Fully Automatic Molding.

STOKES

STOKES MAKES
Plastics Molding Presses,
Industrial Tabletting
and Powder Metal Presses,
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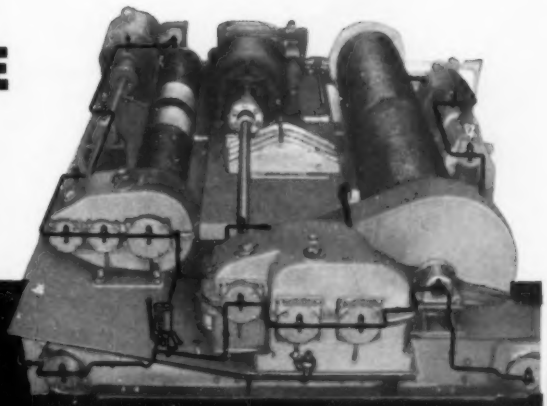
3 ways TO DESIGN MORE PRODUCTION into your machines!



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reduces maintenance, increases machine output

When you design Alemite Accumeter Automatic Lubrication into your machines, you end the need to shut down for lubrication . . . thus adding many hours of profitable production time! An Accumeter System is made up of a lubricant pump, a distribution system of tubing, and *force-feed* valves for individual bearings. From one central point, it automatically lubricates all the bearings on a machine . . . while the machine continues to produce. Eliminates the risks of lubrication errors or neglect by your customers! Soon pays for itself in increased production . . . man hours, lubricants and repair costs saved!

Alemite Accumeter Systems meter oil or grease to bearings with a degree of accuracy never before achieved. In fact, even after 73,312 lubrication cycles, equal to 122 years of twice-a-day service . . . tests show *no variation* in the amount of lubricant discharged! What's more, lubrication is either fully hydraulic or continuous between cycles, thanks to Alemite's exclusive "accumulating" feature that *prolongs* the discharge of lubricant to bearings!

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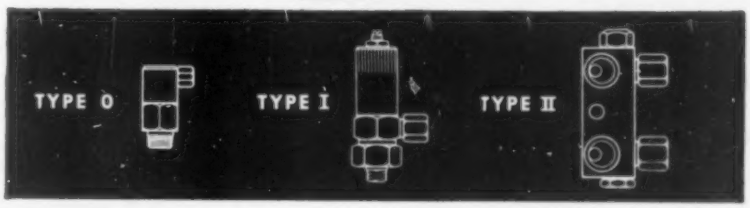

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Fixed output metering valves for single line system serving up to 200 small bearings. Especially suited to precision machines, and wherever space is limited.

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Oil or grease metering valves with *fixed or adjustable output*, for single line system. Valves for any bearing capacity. Single system serves up to 400 bearings.

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Adjustable output metering valves for oil or grease. Each serves 2 bearings. System handles up to 600 bearings. Manual or automatic operation.

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INCREASE YOUR

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PRECISION PARTS ARE DELIVERED READY FOR ASSEMBLY WITHOUT FURTHER PROCESSING!

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PMP

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Extremely sensitive

PRESSURE & VACUUM *Switches*

TYPE SB

The new Type SB pressure and vacuum switches are for use in applications in which close on-off differentials and absolutely consistent maintenance of cut-in and cut-out settings are essential in the control of pressure or vacuum. Available are two pressure models and two vacuum models. The Pressure Switches have adjustable ranges from 0-15 psi and adjustable on-off differential from .1" wc-10" wc. They may be furnished as calibrated, micrometer type or uncalibrated for screw driver adjustment.

Electrical ratings at 125/250 V AC between 1200 watts and pilot duty depending on differential. The Vacuum Switches offer adjustable ranges from 30"-0" hg vac with adjustable on-off differential from .1" wc-10" wc. Furnished as calibrated micrometer type or uncalibrated with screw driver adjustment. Electrical ratings of both models 1200 watts at 125/250 V AC.

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Watertown, Mass.

Special models available for requirements not included in the specifications above.

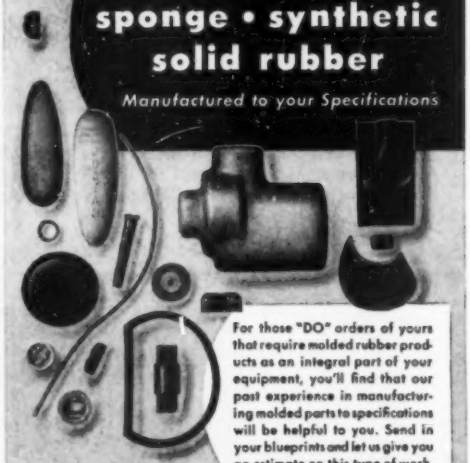
Write for new bulletin 4926 P giving complete details today.

STANDARD & SPECIAL THERMOSTATS & PRESSURE SWITCHES

PRECISION
MOLDED RUBBER PRODUCTS

sponge • synthetic solid rubber

Manufactured to your Specifications



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VAN CLEEF BROS. INC.
Manufacturers Rubber Products Est. 1910
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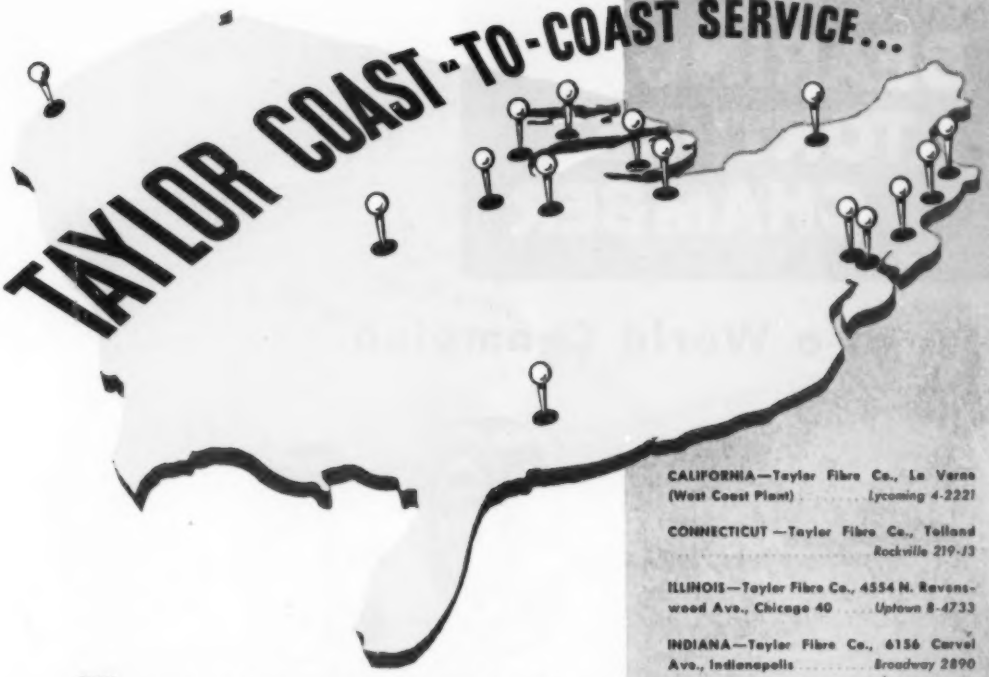

Wherever your plant may be located, there's a Taylor Sales Engineer ready to serve you. Call on him when you want the *best* in Vulcanized Fibre, Phenol Fibre, Special Glass Melamine and Silicone Laminates. Ask him, too, about the complete Taylor Fabricating Service—designed to help you save time, trouble and money on your machining operations.

This new 1951 Taylor Catalog contains complete specifications and description of Taylor Laminated Plastics. See for yourself how these versatile materials can help you produce your product or part better, faster and at lower cost. Write today for Catalog PE5.

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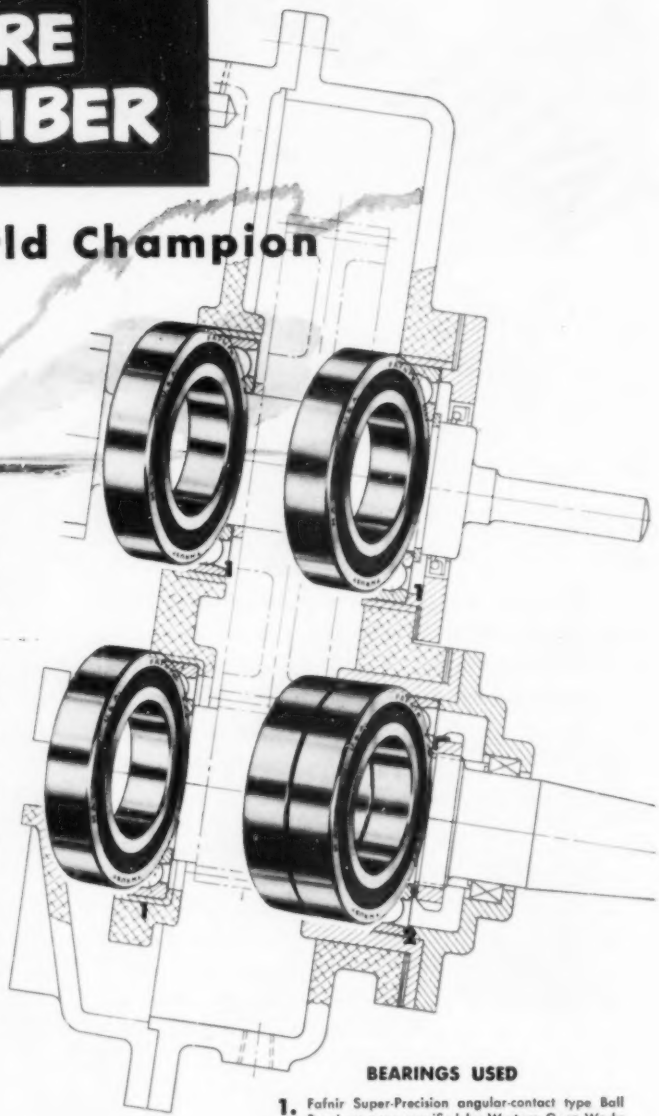
BEARING TORTURE CHAMBER

of a World Champion

In this spur gear box, the world's fastest boat, Stanley Sayres' "SLO-MO-SHUN IV", gets its amazing drive. The gear box uses 5 Fafnir Super-Precision Ball Bearings — as against 8 in competing boats.

Beside winning both the Gold Cup and Harmsworth Trophy Races in 1950, "SLO-MO-SHUN IV" set the world's straightaway record of 160.3 mph for a mile. The straightaway runs were made with a damaged drive shaft which made it unwise to use full throttle. Even so, the 3 to 1 step-up ratio turned the output (propeller) shaft at 11,100 R.P.M. and the tandem duplex bearing was taking a thrust load of over 4600 pounds.

Although you may not have bearing problems to match this one, you'll find it to your advantage to discuss them with a Fafnir representative because Fafnir's experience is not limited to just a few industries but is industry-wide. The Fafnir Bearing Company, New Britain, Conn.



BEARINGS USED

1. Fafnir Super-Precision angular-contact type Ball Bearings were specified by Western Gear Works of Seattle who designed and built the gear box for "SLO-MO-SHUN IV".

2. Similar to those above except these bearings are duplexed to provide greater axial and radial rigidity.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

Excerpts from

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R. R. to H. W. C. to 8/30/50

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pointed out considerable savings possible by shifting to Nylclad. Purchasing Department estimated this totals almost $50,000 for the year.

Company "B"

large motor manufacturer has made extensive tests with Nylclad. Savings resulting from use estimated $20,000. Engineer stated that none of competitive wires checked were nearly as good as Nylclad from heat and pressure resistance standpoint.

Company "C"

This manufacturer of special equipment has approved Nylclad on the basis of chief engineer's recommendation. Most enthusiastic about its resistance to the solvent action of hot varnish.

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Winding foreman, previously highly critical, said, "Nylclad is great stuff — it got me out of a hole." He liked the high abrasion resistance against winding abuse.

Company "E"

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Company "F"

Engineer, after testing Nylclad, told buyer he was convinced it was excellent wire and recommended its use. He noted its uniform solderability.

NYLCLAD MAGNET WIRE combines the desirable properties of Formvar and Nylon types. Its tough, durable coating eliminates the need for paper- or textile-covered wires (in many applications) and reduces winding space requirements. It solders uniformly at 1050 F. Nylclad* provides increased toughness to resist winding abuses, increased solvent resistance, and resistance to softening under heat and hot varnish; it is not subject to solvent crazing. Nylclad's "slipperiness" means improved windability — more compact coils — many over-all plus values at *no* increase in price.

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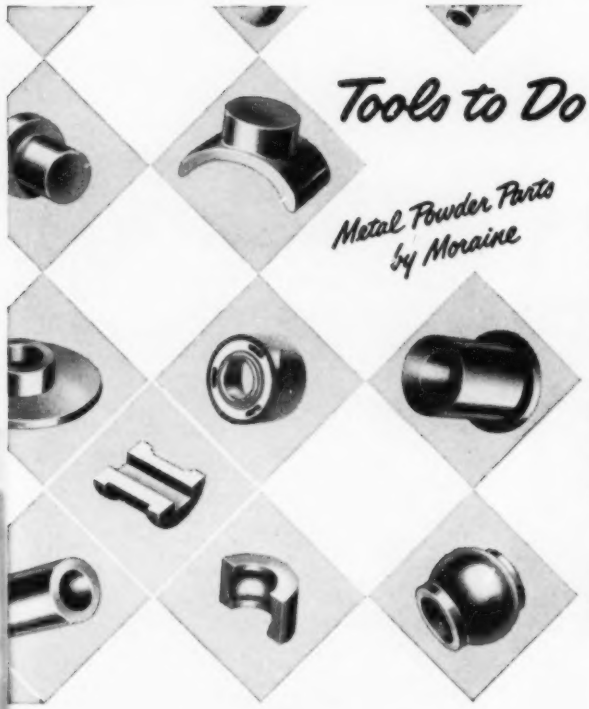
Nylclad* by Belden

*TRADE MARK

THE MAGNET WIRE WITH THE PERFECTED INSULATION



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Metal Powder Parts by Moraine

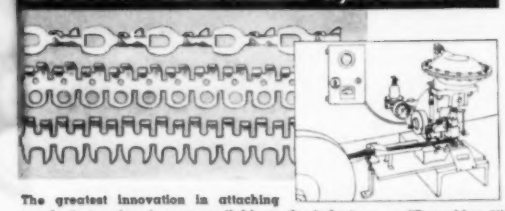
Billions of metal powder parts represent not only a tremendous production achievement but a know-how that has been built up carefully over a quarter of a century.

Complicated dies, special presses, sintering furnaces, and other equipment essential to the production of parts from metal powder—plus production and process know-how—result in parts with close tolerances and of intricate design for a wide range of applications.

Moraine has demonstrated its ability to produce parts faster and at lowered costs for many customers.

MORAINE PRODUCTS
DIVISION OF GENERAL MOTORS
DAYTON, OHIO

Now Terminals Can Be
ATTACHED & SOLDERED
in ONE Automatic Operation!



The greatest innovation in attaching terminals to wires is now available to the industry . . . "Pre-soldered" TANDEM TERMINALS! Made in various sizes and types, these remarkable, production-proved terminals (supplied on reels) can be applied at rates up to 1200 per hour by a new Terminal Attaching Machine that cuts off, clinches and solders terminals in one instantaneous operation. Handling of loose terminals, solder and flux are eliminated to reduce costs and boost production on long runs. Standard types available. Send for detailed information, enclose sample of wire and terminal now used. Address Dept. E.

For ordinary runs in moderate quantity we continue to produce
SEPARATE TERMINALS for ELECTRIC WIRES

We also make SMALL METAL STAMPINGS Exact to Customer's Prints. Modern Plant and Equipment. Moderate Die Charges. Precision Work. Prompt Service.

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first choice
for...
- DEPENDABILITY
- ACCURACY
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THE MARK-TIME "2000" BELL TIMER

This economical, rugged bell timer is adaptable to numerous types of equipment. It is the ideal timer for industrial applications in the timing of any predetermined time cycle at the conclusion of which a clear, resonant bell signal is desirable.

The Series "2000" Bell-Timer is available for center stud mounting only and in various arbor lengths and bushings to accommodate any application. Standard timings from 60 seconds to one hour.

Write for further details and prices.

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With nearly sixty years experience in the production of both laminated and solid precious metals, MAKEPEACE is today an accepted "headquarters" for the many special precious metal products and assemblies called for in the electronic field.

FOR RINGS AND WAVE GUIDE TUBING
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special gasketing that both seals and conducts high frequency currents. It makes an air-tight seal and yet prevents leakage of high frequencies between the bolt holes.

Cohrlastic conductive gasketing provides a continuous mounting and minimizes high frequency losses that affect radio operation.

It is widely used in aircraft (1) between the magnetos and their bases, (2) in the ignition harness, (3) in quick disconnect plugs and (4) wherever shielding is required.

Cohrlastic conductive gasketing is available in three different thicknesses—.016", .020" and .028" in rolls 8" wide and in the finished gaskets on a custom basis. Write for samples, prices and data sheets.

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Series universal motor parts for portable tools, portable business machines and many household appliances.

Series motor suitable for many intermittent duty applications where space and weight are important considerations.

Improved Product Performance

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Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER MOTORS

A motor engineered for compact assemblies . . . as computing machines and other types of motor driven office equipment.

Rugged construction is a major factor in the reliability of this motor widely used in the field of mechanized equipment.

A motor engineered to the exact requirements of your product generally results in greatly improved product performance.

Lamb Electric special application motors, built to precision standards of high quality materials, also make available:

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- Reduced cost, weight, space.
- Exact mechanical and electrical requirements.
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- Improved eye appeal.
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We shall welcome the opportunity to discuss these benefits in terms of your particular applications.

THE LAMB ELECTRIC COMPANY • KENT, OHIO

Planetary inbuilt speed reducer provides straight line drive, quiet operation and long gear life.

Space factor minimized in this high torque universal motor with a spiralled gear drive.

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AMERICA'S Finest PRODUCTS

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

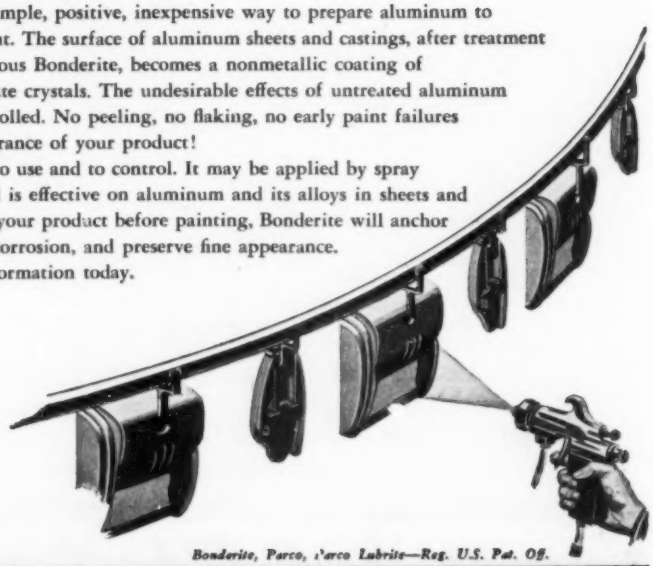
BEFORE YOU PAINT ALUMINUM

Famous corrosion resistant paint base ends peeling and flaking, preserves appearance

Bonderite is the simple, positive, inexpensive way to prepare aluminum to take and hold paint. The surface of aluminum sheets and castings, after treatment with Parker's famous Bonderite, becomes a nonmetallic coating of fine-grain phosphate crystals. The undesirable effects of untreated aluminum on paint are controlled. No peeling, no flaking, no early paint failures to spoil the appearance of your product!

Bonderite is easy to use and to control. It may be applied by spray or immersion, and is effective on aluminum and its alloys in sheets and castings. Used on your product before painting, Bonderite will anchor the paint, retard corrosion, and preserve fine appearance.

Write for full information today.



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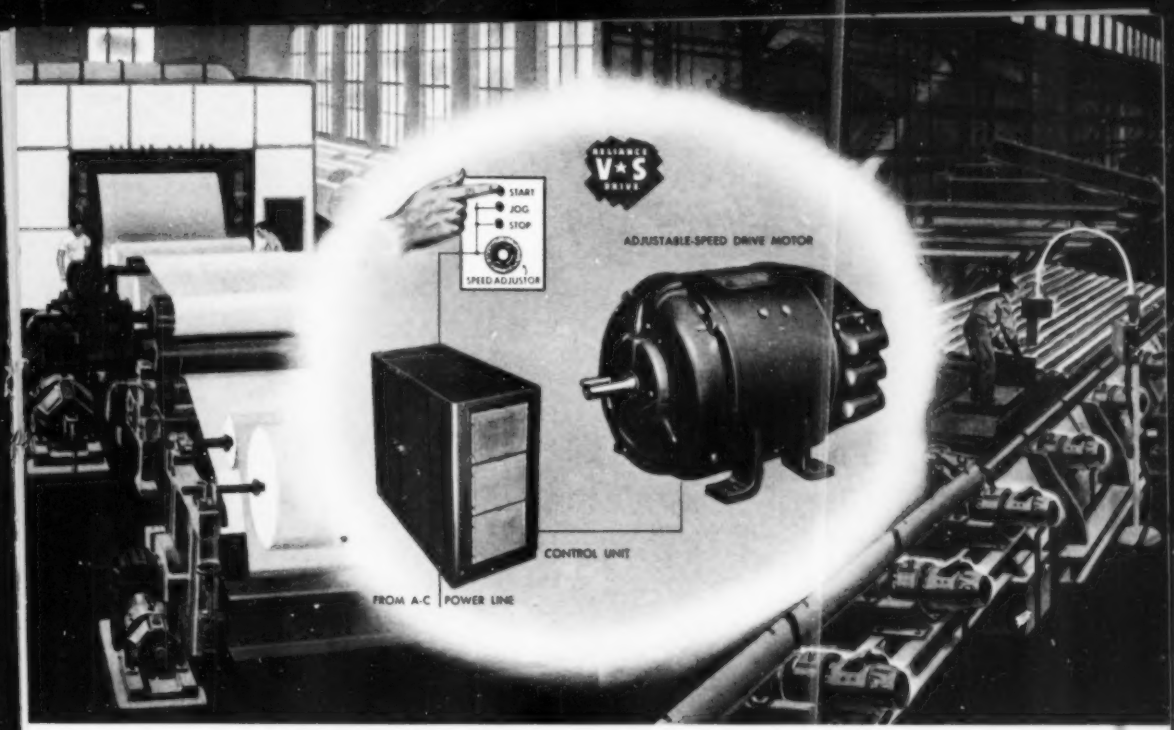

The Most Effective Method

OF POWER TRANSMISSION SERVING INDUSTRY TODAY . . .

RELIANCE V★S DRIVE ®

12 years ago Reliance introduced the V*S Drive . . . a tremendous forward step in the evolution of the application of power—an electrical transmission. It placed at the service of industry the most effective method of power transmission in use today! Operating from a plant's A-c. circuit, V*S provides controlled acceleration and deceleration—quick, smooth starts and stops—reversal at any point as well as an infinite range of stepless speeds. Here is flexibility of operation which pays big dividends in greater production—and lower operating costs. Do *you* have it? Write for Bulletins 311 and D-2101.

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more details on the other side . . .

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which gives you

STARTING without clutches!

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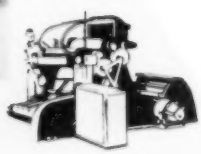
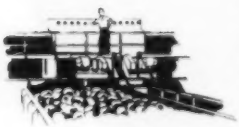
REVERSING without use of gears or clutches!

ADJUSTABLE SPEEDS without mechanical transmissions or change of gears!

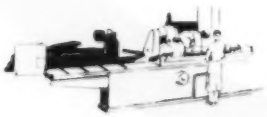
JOGGING, INCHING, CREEPING without slipping clutches!

. . . from A-c. Circuits





Contact a Reliance Application Engineer or write today for Bulletin 311 (V★S Drives through 300 horsepower). Ask also for Bulletin D-2101 describing the smaller Reliance V★S Drive, in sizes from 3/4 to 3 horsepower.



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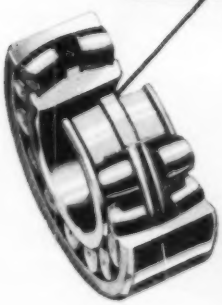
. . . thanks to Westinghouse Sturtevant fans

bearings by SKF

Slicing under the Houston Ship Channel, Washburn Tunnel is guaranteed abundant fresh air, regardless of heavy traffic, thanks to the last word in engineered ventilation.

Two huge Westinghouse-Sturtevant Fans, regulated by automatic electronic controls, supply a complete change of air every two minutes. They have a maximum capacity of 684,000 CFM . . . and friction, need for lubrication and inspection are held to the minimum by SKF Spherical Roller Bearings. It is because of a well-earned reputation for dependability, because of their self-aligning properties and their ability to deliver continuous trouble-free service under adverse conditions that SKF Bearings have been specified for most of the country's major tunnel-fan installations.

7213



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AN OPEN-AND-SHUT CASE OF *Good Design*

No matter how you look at it, the Lady Betty Lunch-N-Bag, designed by Sundberg-Ferar, is an outstanding new use for Hercocel* A. Open, this smart new accessory reveals itself to be a well-integrated combination of purse and lunch box (fitted with standard vacuum bottle). Shut, and slung over milady's arm or shoulder, it's a handsome, high-styled handbag with a rich brown finish in gleaming plastic. Both inside and out, it's built for long-time service and satisfaction. Little wonder the current demand for this attractive new product far outstrips supplies!

Lunch-N-Bag is another example of the way Hercules materials and facilities contribute to the development and production of new and better things made of plastics. Our design and technical staffs invite your inquiries on "Hercocel" A or other Hercules Cellulosic Plastics.

HERCULES POWDER COMPANY Cellulose Products Dept., 994 Market St., Wilmington, Del.

Please address inquiries about the new Lunch-N-Bag to the manufacturer — Landers, Frary & Clark, New Britain, Conn.

HERCULES Cellulosic Plastics

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18 B & S Ga. Aluminum Seamless Drawn Brazed to die cast frame
Length—15¼" Width—9¾" Height of Case—5"

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Seamless drawn base welded to electrically welded body. Seamless drawn perforated insert is hot dip galvanized 18 and 20 U.S. Ga. Steel.
Height—20".
Diameter of base—18½".

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Seamless Drawn Copper—20 U.S. Ga.
Height—2⅝"
Width—6⅜"

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Seamless Drawn Steel—16 U.S. Ga.
Height—7⅝"
Diameter—6¼"

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Seamless Drawn Steel—16 U.S. Ga.
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Length—10¼" Width—9⅛" Height—6⅛"

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HELI-COIL SCREW THREAD INSERTS SIMPLIFY DESIGN AND ASSEMBLY

These stainless steel wire inserts, precision-formed to assure Class III fit, permit simpler design, lighter weight, fewer bolts, shorter thread engagements... eliminate costly solid bushings, provide lighter boss and flange design, improve all threaded products. Heli-Coil Inserts fit National Coarse and Fine Threads, automotive and aviation spark plugs, and taper pipe threads. Meet all aircraft, industrial and military specifications.

Cost is 75% less than solid bushings, space required 50% less. There is no wear from assembly and disassembly, however frequent. Strength is greater and product is completely free from screw-thread complaints for product service life.

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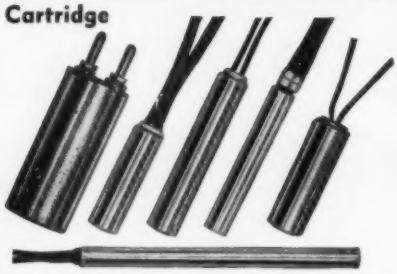
VULCAN

ELECTRIC HEATING UNITS

Cartridge



Standard Sizes: brass sheath. Maximum temperature 750° F. .373" to 1,291" diameter. 110-250 volts.

All sizes .622" or larger, can be had for three heat. Units .933" or larger, with any type terminal.

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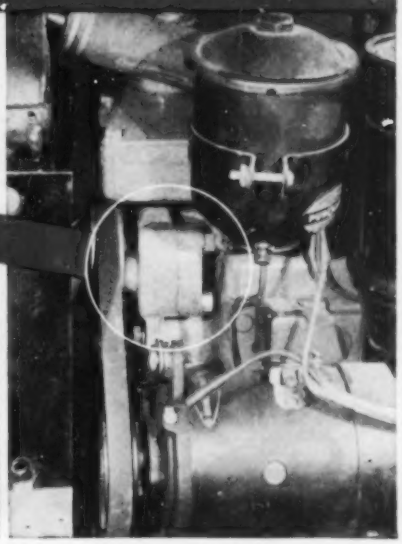
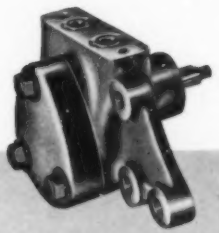
"The sensitive response of the hydraulic system permits such trigger-fine adjustment that operators are loud in their appreciation," says Massey-Harris . . . *the sales power of hydraulic power in action.*



Circle shows position of Pesco pump.



Pesco pump designed for Massey-Harris Pony tractor. Capacity: 2.5 g. p. m. @ 2880 r. p. m. @ 1000 p. s. i.

Pesco *Dual Purpose* Pump Eliminates Extra Power Shaft on Massey-Harris Pony

The problem was to eliminate all unnecessary weight and cost and save space on a small tractor.

So Massey-Harris tractor engineers and Pesco hydraulic engineers teamed up . . . together came up with a specially designed dual purpose hydraulic pump to serve as both pump and fan bearing mounting.

Result: less space and weight required . . . necessity for an extra motor power shaft is eliminated.

Such teamwork between Pesco and client engineers is frequent. Matching hydraulic know-how and skills with the engineering knowledge of a manufacturer's engineering staff is the way we at Pesco like to work. It is teamwork that puts the sales power of hydraulic power to work to full advantage for our customers.

If you have a problem in hydraulics Pesco engineers will gladly co-operate with your engineers to solve it. Write today.

engineering Pesco production

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When the first electric fan laid the foundation for modern air conditioning back in the 80's, KOVEN was fabricating individualized equipment parts. Today, leading equipment manufacturers depend on KOVEN to design and supply the precision parts they need to produce efficient machinery. Backed by 70 years' engineering know-how and modern workshop facilities, we are geared to turn out individualized parts faster, and often more economically than your own plant production line will allow. Call or write for a consultation with a KOVEN representative today—no obligation.

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72" dia. x 20' long horizontal tank

Plants:

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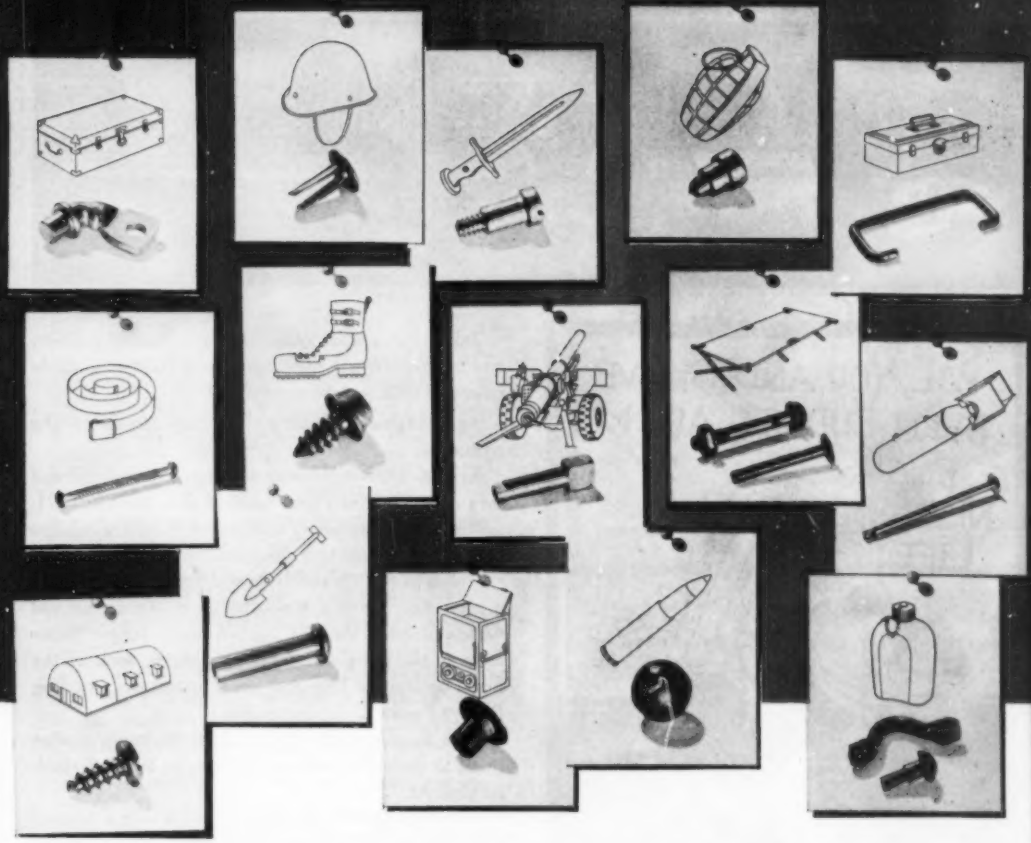

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You reduce costs and speed delivery of military items by calling upon Townsend's past experience in producing special fasteners and parts for all types of Army and Navy material.

Townsend has made parts for a multitude of items from rivets for cots and beds to balls for artillery canisters — from hob nails for field boots to rivets for half track treads — from sheet metal screws for Quonset huts to pins and burrs for pup-tent poles— from special nails for gliders to large rivets for tanks— from handles for tool chests to screws for bayonets —to name but a few.

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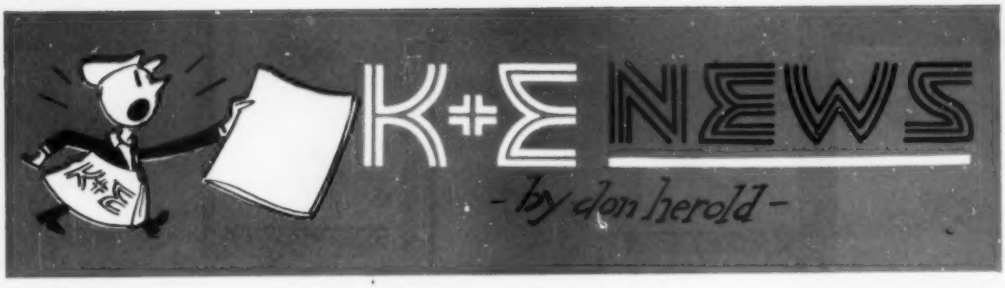
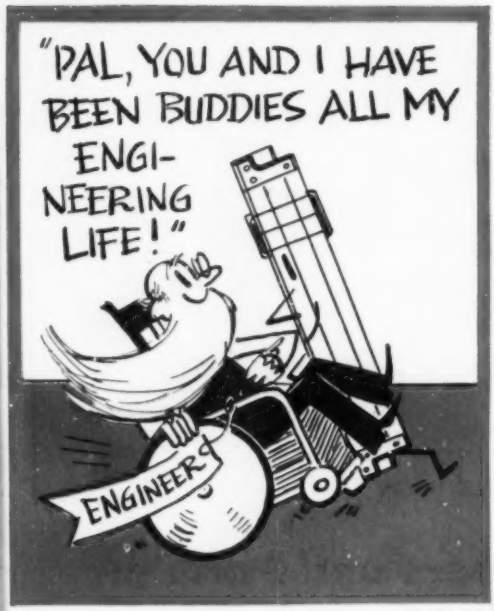




Down through the years with a K&E Slide Rule

Although K&E Slide Rules are the oldest slide rules made in America, there are no whiskers on 'em—except cat's whiskers (I mean, symbolizing precision).

If you are an old engineer, you probably regard your K&E Slide Rule as a priceless Stradivarius. You are probably figuring on passing it down to your grandchildren.

If you are a beginner, the sooner you attach yourself to an immortal K&E rule, the better.

K&E Slide Rules have become accepted symbols of the engineering profession. If a photographer, illustrator or cartoonist wants to indicate that his hero is a top-flight engineer, he puts a K&E Slide Rule in his hand or in the immediate environment.

Ask anybody what he knows about Keuffel & Esser, and he first starts rhapsodizing about slide rules. Slide rules and K&E are synonymous.

And they're both almost as long lasting as the pyramids!

Keuffel & Esser have been around since 1867 and they completed their first batch of slide rules in 1891.

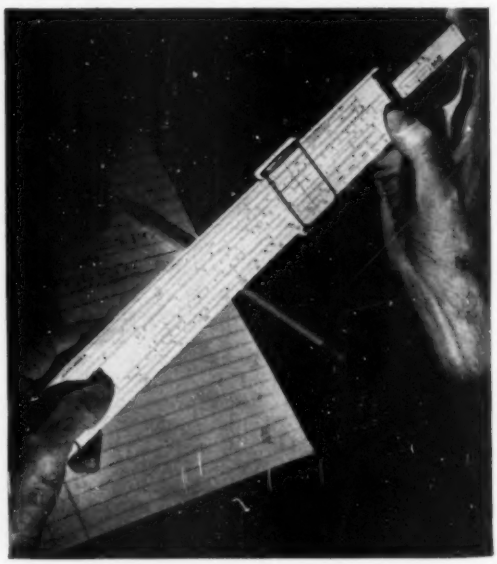
It is not uncommon to hear of a K&E rule which has been in service for over 50 years.

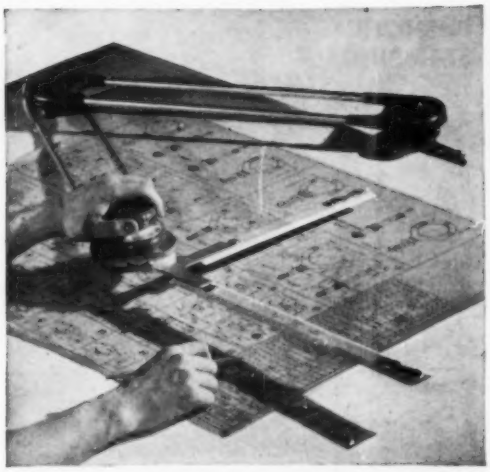
I used to think a slide rule was a slide rule—just as a yard stick is a yard stick—but there is a sensational variety of 'em in the K&E line—from the simple Mannheim to the more complicated brethren, such as the Log Log Duplex Trig and Decitrig and the Log Log Duplex Vector*.

Also, there are several sizes from the handy pocket rules, to the more common 10-inch, up to the 20-inch longfellows.

There's no point to hitching up for life with a "second best" slide rule when you can play a Keuffel & Esser.

*Trade Marks ®



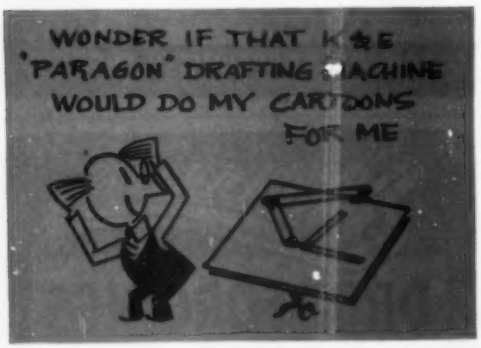


it's twice as fast as "human" drawing

You wouldn't try to be Rachmaninoff without a piano, or a Kreisler without a fiddle. Well, who would want to be a draftsman without a K&E PARAGON† DRAFTING MACHINE?

This miracle machine makes you a veritable orchestra leader at your drawing board. It combines T-squares, triangles, protractors and scales, all in one unit, controlled entirely by one hand.

You can move a rule all over the board, and the rule stays parallel to its original position. You can draw all lines to exact length. The lightest touch rotates the scales to any angle desired.



Permanent accuracy is assured, because the open center arm construction makes it practically impossible to disturb the factory-set band tension.

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this whee-e-eraser saves time and elbow grease

This K&E MOTORASER* makes old-fashioned hand erasing look horse and buggy. It reduces your erasing time to seconds.

Since it depends on speed rather than pressure, the MOTORASER does not wear holes in paper. It's as accurate as a pencil point, yet will clean large areas in a jiffy.

It's handy in the hand—a 3 inch palm full with a finger-tip switch—only 6 oz. Uses AC juice—60 cycle 110 volt AC—or DC with an inexpensive adapter. A sturdy little feller, too.

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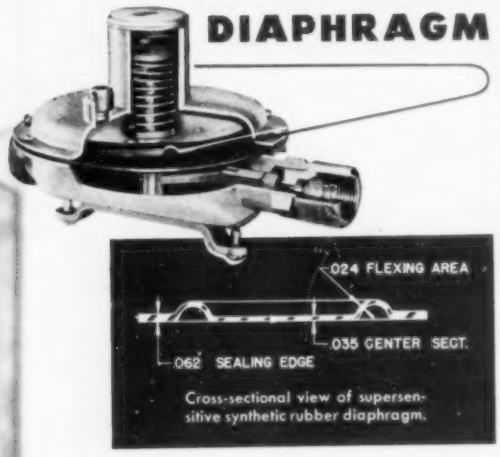

Cross-sectional view of supersensitive synthetic rubber diaphragm.

TYPICAL is the result obtained with the LINEAR Diaphragm, shown above. Precision moulded to a .062" edge, .024" at the flexing area, and .035" in the center section, this super sensitive diaphragm assures a consistently uniform delivery pressure over a wide range of inlet pressures.

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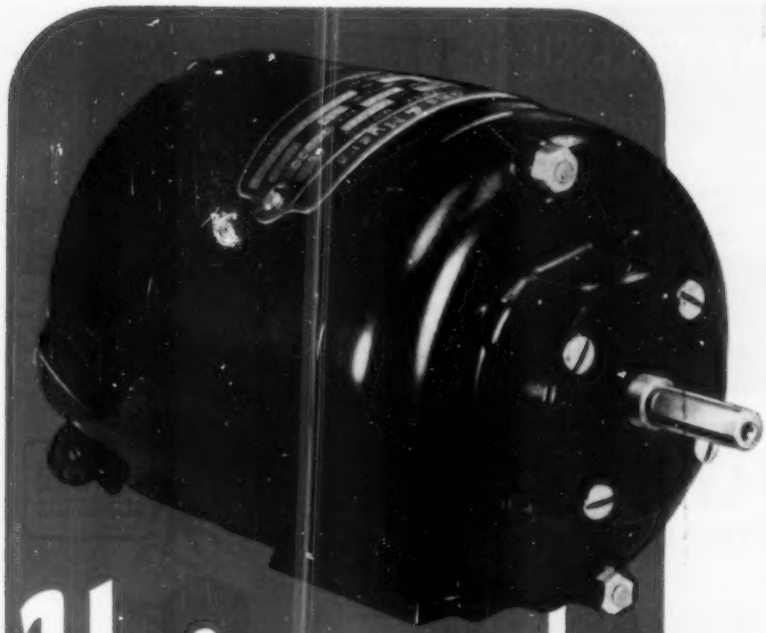

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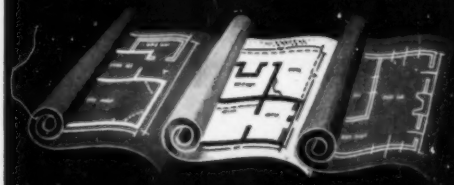

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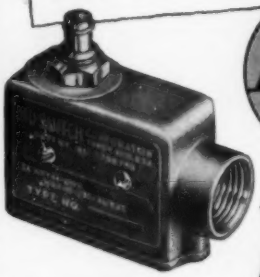
AMERICAN PENCIL COMPANY
Hoboken, New Jersey
Dept. PE 551

Please send me free Venus *Technical Test Kit* with two Venus Drawing Pencils in these degrees: ( ) ( ).

Name .....
Company .....
Street .....
City ..... *State* .....

Memo to All Designers...

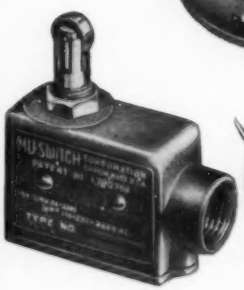
TEAR OUT THIS AD AND MAIL WITH NAME AND ADDRESS FOR COMPLETE INFORMATION



METAL-CLAD SWITCHES

Snap-action switch mechanism sealed against dirt and moisture within a strong metal casing

Optional side or flange mounts, male or female conduit connections



Available with a variety of actuators; roller, plunger, sealed plunger, pin, leaf, etc.

ALL RATED AT 20 AMPS, 125 VOLTS, A. C.

Protected metal clad Mu switches provide precise dependable control over electric circuits on machine tools, processing equipment, packaging machines, aircraft, ships, tanks, etc. We'll gladly work with you on special applications. Just send us the details.

SAY "MEW"

Mu-switch

DIVISION OF ACRO MANUFACTURING COMPANY
CANTON, MASS.

Adhesives eliminate rivets in attaching automobile clutch facings. This eliminates slow and costly riveting operations and reduces the danger of damage from rivets. This 3M adhesive application decreased the number of rejects.

Strippable Coatings protect metal from scratches, abrasions and mars during the manufacture of many products. One user reports savings of more than $100 a day in terms of speeded production and elimination of rejects.

ADHESIVES COATINGS SEALERS

3M COMPANY

Sealers for Integral Fuel Tanks serve both military and commercial aircraft. This application of a 3M adhesive makes possible the sealing of wing compartments to serve as fuel tanks, rather than using separate fuel cells which are heavier and more costly.

IT TAKES TEAMWORK TO MAKE THINGS STICK!

The problem of making one material stick to another requires the same type of research and engineering necessary in many other technical problems.

That's why 3M offers you not only top-product quality but *service* . . . service based on the teamwork of our skilled research technicians and laboratory-trained field engineers. These specialists are always available to consult with you on problems of design and production. From field reports, research technicians can draw from over 1,000 basic formulas to select the right adhesive for your requirements.

With 20 offices conveniently located to help you, 3M service is as close as your telephone; or, write directly to Dept. 45 in Detroit.

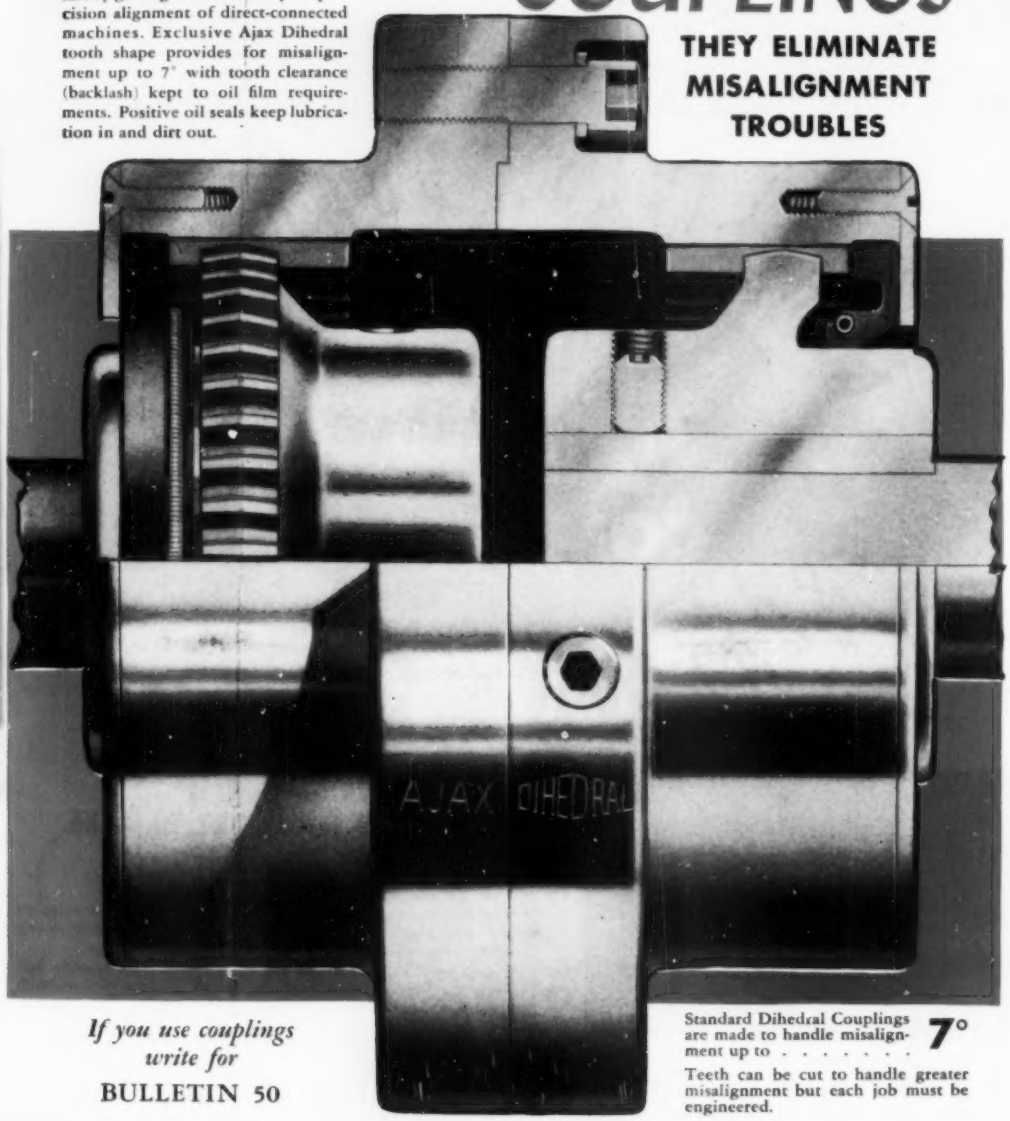
ADHESIVES AND COATINGS DIVISION • **MINNESOTA MINING AND MANUFACTURING COMPANY**
411 PIQUETTE AVE., DETROIT 2, MICH.
GENERAL OFFICE: ST. PAUL 6, MINN.
EXPORT AND CANADIAN SALES: 270 PARK AVE., NEW YORK 17, N. Y.

Announcing AJAX DIHEDRAL COUPLINGS

*

Design, installation and maintenance men can now save thousands of dollars by getting rid of necessity for precision alignment of direct-connected machines. Exclusive Ajax Dihedral tooth shape provides for misalignment up to 7° with tooth clearance (backlash) kept to oil film requirements. Positive oil seals keep lubrication in and dirt out.

THEY ELIMINATE MISALIGNMENT TROUBLES



If you use couplings write for

BULLETIN 50

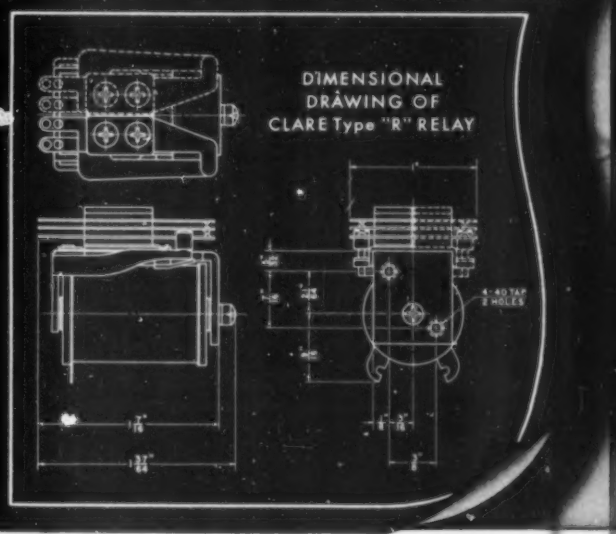
Standard Dihedral Couplings are made to handle misalignment up to . . . . . 7°

Teeth can be cut to handle greater misalignment but each job must be engineered.

AJAX FLEXIBLE COUPLING CO. INC. Westfield, New York

A NEW CLARE RELAY...

the Type "R" combines extremely small size with unusual sensitivity and long life



SPECIFICATIONS

SIZE
Length: 17/16"—Height: 1 3/64"—Width: 1"

WEIGHT
Approximately 2 ounces

COIL
Single or double-wound

OPERATING VOLTAGE
Up to 230 volts d-c

ARMATURE
Single or double arm

CONTACT ASSEMBLY
Form A to C. Maximum of 10 springs in each pileup.

MOUNTING
Two #4-40 tapped holes in end of heelpiece

● This new CLARE Type "R" d-c Relay embodies many features of the famous CLARE Type "K" Relay, which was the first to combine the advantages of a telephone-type relay with the small size, light weight and resistance to vibration required to meet the rigid demands of aircraft service.

In appearance, the Type "R" resembles the Type "K", but, through hardly noticeable structural differences, CLARE has given the new Type "R" even greater sensitivity and operating range. Both relays use the same contact springs, but the Type "R" coil is longer and of larger diameter, to provide greater winding space. Life expectancy of the new relay has been not only increased but multiplied.

The CLARE Type "R" Relay retains in an improved form the reed armature suspension which discerning engineers have come to recognize as one of the subtler reasons for the superior performance of CLARE Type "K" Relays over other relays of comparable size and somewhat similar appearance.

The Type "R" is available as either an open or hermetically sealed relay. Clare sales engineers are located in principal cities to give you firsthand information on this new relay and to cooperate with you on any complex relay problem. Call them or write to C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY.

Write for CLARE Bulletin No. 115

CLARE RELAYS

First in the Industrial Field

If YOUR INDUSTRY is on this list—

PAPER
AERONAUTICAL
MACHINE BUILDING
BUSINESS MACHINES
TELEVISION - RADIO
HOUSEHOLD APPLIANCES
SPORTING GOODS
SAFETY FOOTWEAR
AGRICULTURE
AUTOMOTIVE
TEXTILES
MEDICAL
LEATHER

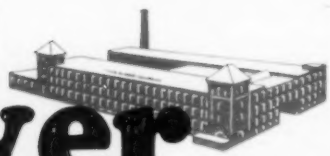
you can benefit from

Tyer

Skill, Imagination & Service

Tyer technical knowledge and original thinking are available to you to make Rubber, *our* product, more useful to you in *your* product. The same know-how and resourcefulness that led Tyer to originate White Rubber and Elastic Webbing in the early days of the industry, have enabled Tyer, through war and peace, to supply American manufacturers with

THE UNUSUAL IN RUBBER SINCE 1856



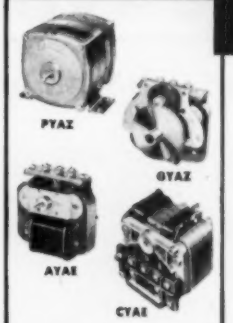
Tyer
RUBBER COMPANY

ANDOVER, MASSACHUSETTS

159 Duane St., **NEW YORK** 189 W. Madison St., **CHICAGO**
6-234 General Motors Bldg., **DETROIT**

Fast-Reversing
LOW INERTIA

BARCOL MOTORS



Shaded-Pole Type • No Commutator • No Arcing Contacts • 25-60 Cycles • 1/5000 to 1/50 Horsepower • With and Without Reduction Gearing

Write for Catalog

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SERVO MECHANISMS
TELEVISION TUNERS
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Adaptable to . . .
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OTHER BARCOL MOTORS: UNIDIRECTIONAL, SYNCHRONOUS, AND ASYNCHRONOUS.

BARBER-COLMAN COMPANY
ROCKFORD • ILLINOIS

Miniature Ball Bearings

MPB Superlight Miniature Ball Bearings are designed for large shaft, small housing installations. They are one of more than 50 types and sizes manufactured to the highest precision tolerances in our completely air-conditioned plant.

Standard extra operations assure you of finest quality components for your instruments. (MPB bearings for example are burnished, not merely ground, on all functional surfaces).

MPB bearings are made by the experienced originators of miniature ball bearings, and are supplied in factory sealed vials, lubricated and ready for installation.

Complete and competent engineering assistance for your applications is promptly available, through 18 convenient offices with bearing stocks in East, West and Mid-Continent cities.

You'll find our catalog complete and convenient: shows actual sizes, full specs and prices on more than 50 different miniature ball bearings. See Sweets PD File or by mail immediately.

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MINIATURE PRECISION BEARINGS, INC.
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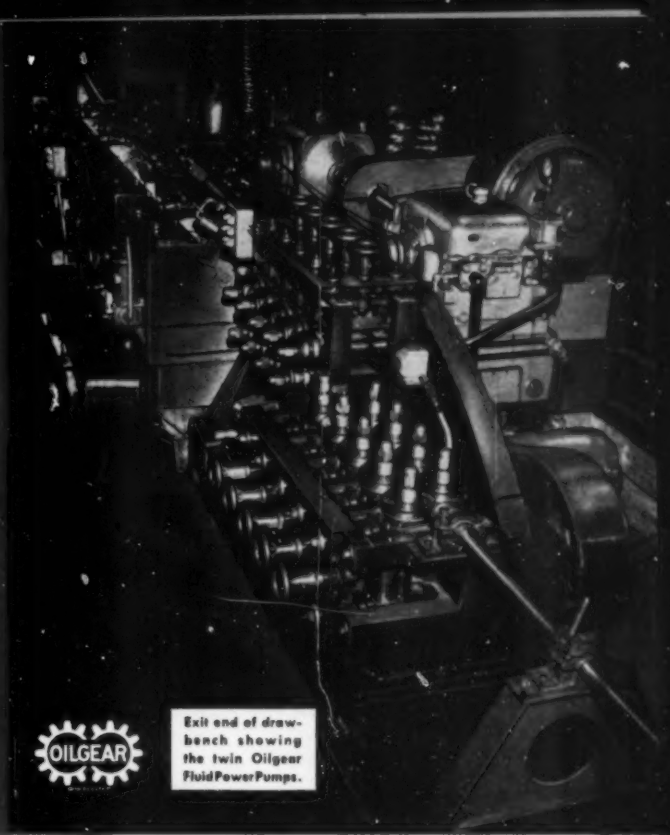
Amazing Lomatic Doubles and Triples Past Output

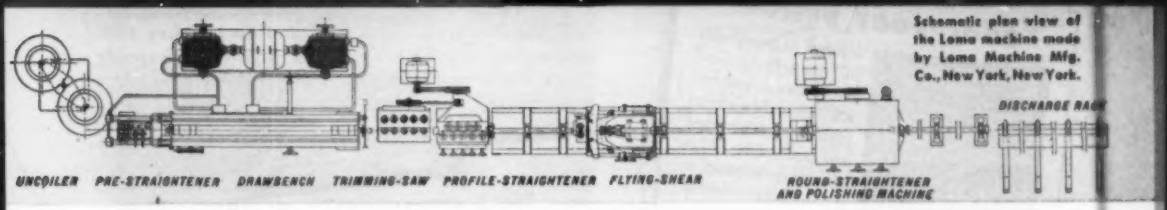
EMPLOYS

OILGEAR

AT CRUCIAL POINTS



Exit end of drawbench showing the twin Oilgear Fluid Power Pumps.



Schematic plan view of the Loma machine made by Loma Machine Mfg. Co., New York, New York.

AN unusual type of rod-processing machine produces finished stock at a rate two to three times faster than on conventional drawbenches or other types of continuous drawbenches.* Drawing, straightening, shearing and polishing of brass rod are done in one operation on these Oilgear-equipped Lomatic machines.

Oilgear variable delivery pumps, cylinders and valves operate feed roll clamp to start rod through the pre-straightener. The Oilgear equipment provides synchronized operation in tandem and high-speed alternate drop-back in the draw carriage cycle. These functions are crucial to the successful operation of the Lomatic. The wonderfully smooth and steady drawing speed gained from Oilgear equipment means the production of uniformly high quality stock. The operator has full manual control of his machine for set-up and test purposes. He has remote pushbutton control of each carriage . . . and full automatic continuous operation. These superiorities result from the Oilgear simplified fluid power and control system.

Here is another outstanding achievement in machine design where Oilgear Fluid Power plays an important role in enabling the designer and builder to gain the requisite flexibility of application and control of power, simplicity of construction, engineering and installation, sturdiness, and built-in protection against overload.

You can do things with *this* power you *CAN'T* do with any other power . . . and you can do them *BETTER* with Oilgear Fluid Power equipment. What is your problem? Write THE OILGEAR COMPANY, 1571 W. Pierce Street, Milwaukee 4, Wisconsin.

*See article "Brass Rods" published in THE IRON AGE, April 14, 1949.

See Sweet's 1950 File for Product Designers, Section 4C/6.

Oilgear

PIONEERS IN FLUID POWER

Pumps, Motors, Transmissions, Cylinders, and Valves

HERE'S WHY

no other coupling costs as little to use as *FAST'S*

With Fast's Couplings you get the lowest coupling cost per year that modern engineering can provide—*because Fast's normally outlast the equipment they connect.* That means their cost can be spread out over 20 years or more!

As two users recently said:

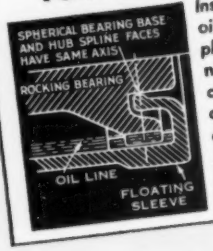
"We've had this Fast's Coupling since 1930 . . . and it's apparently going to last forever. [Wish] the other equipment caused as little trouble!" . . . "We have two Fast's Couplings . . . they are the only equipment so trouble-free we long ago forgot we had them!"

If you want lower costs, freedom from coupling shutdowns and dependable coupling engineering—specify Fast's. For complete details, mail the coupon for Fast's free catalog. Do it today!

RUGGED CONSTRUCTION:

Fast's still maintains its original design, without basic change or sacrifice in size or material. This assures you freedom from needless and expensive coupling failures.

FOOLPROOF DESIGN:



Instead of perishable oil seals, Fast's Couplings use a permanent metal-to-metal closure to keep dust out and oil in. Oil is always maintained at a safe level whether the Fast's is running or standing still.

FREE SERVICE:

When you specify Fast's Couplings you get Koppers' valuable free coupling service. If your application seems to need a special coupling, Koppers' engineers in many cases can easily modify a standard Fast's Coupling, and save you money!

MAIL COUPON TODAY FOR FREE CATALOG!

KOPPERS CO., INC., *Fast's Coupling Dept.*,
235 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name.....

Company.....

Address.....

City.....Zone.....State.....

KOPPERS

FAST'S

THE ORIGINAL GEAR-TYPE

Couplings

INDUSTRY'S STANDARD FOR 31 YEARS

Since the OBERDORFER INTERNATIONAL Pumps described below are new, with no prior history of use, Washington expects a DEFENSE ORDER or equivalent for their purchase. Free samples are available to O.E.M. accounts.

Introducing

The New Series 2

OBERDORFER INTERNATIONAL

BRONZE Close Coupled ROTARY GEAR PUMPS

For liquid transfer where space is at a premium . . .

Bronze spur gears (Oberdorfer alloy #16438)
2 Mechanical pressure and suction seals
Carbon bearings (oilless)
Bronze housing (Oberdorfer alloy #16001)
2 Micro finished stainless steel shafts

These two motor driven pumps have all-bronze housing and gears, oilless carbon bearings, micro-finished stainless steel shafts (± 25/100,000 of an inch) and are powered by heavy-duty ⅓ h.p. motors* equipped with thermal overload protection.

They are intended to be used wherever a liquid has to be moved from one location to another in quantities up to 240 gallons per hour at pressures from 0 to 100 lbs. per square inch.

They are adaptable for a wide variety of industrial and chemical applications where a corrosion-resistant pump is required and space is limited. Their all-bronze body and gears permit use with most liquids.

* 110 volt AC, Motor standard but specially machined for pump mounting.

DIMENSIONS—Pump Only

Pump No.	Height	Width	Length
No. 1½	2⅞	2 1⅞	4¾
No. 2	3 1⅞	2⅜	4⅞

PUMP No. 1½ CCC

Pump head only (⅛" pipe size).....list $20.00
F.O.B. Syracuse
Complete unit with ⅓ H.P. 110 volt AC thermal overload motor.....price on request

PUMP No. 2 CCC

Pump head only (⅛" pipe size).....list $22.50
F.O.B. Syracuse
Complete unit with ⅓ H.P. 110 volt AC thermal overload motor.....price on request

GALLONS PER HOUR at 1725 R.P.M.

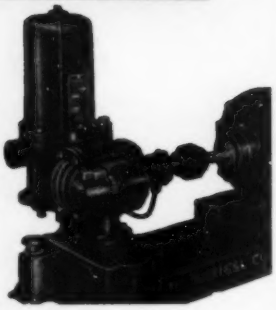
Pressure	Pump No. 1½ CCC	Pump No. 2 CCC
0 lbs.	120 gal.	240 gal.
25 lbs.	110 gal.	220 gal.
50 lbs.	100 gal.	190 gal.
75 lbs.	95 gal.	170 gal.
100 lbs.	90 gal.	——

Write Dept. PE-515

INDUSTRIAL PUMP DIVISION
Oberdorfer Foundries, Inc.
Syracuse, N. Y.

KRAISSL ROTARY AIR PUMPS

For Vacuum and Pressure



Designed for high efficiency—for the packaging and printing machine fields. Rigorous on-job tests prove Kraissl pumps are the economy answer to your vacuum and air-under-pressure problems. Exclusive Kraissl design assures you maximum performance—and lower costs. Compact and lightweight—with exceptionally large capacities for size; force-feed lubrication system gives continuous heavy-duty service.

FREE! Bulletin A-1289 gives you complete data on Kraissl Rotary Air Pumps. Write for it today.

Features of Kraissl Class 25 Air Pumps—

- Run at direct motor speeds—but not limited to motor operations
- Integrated oil-air filter available
- Forced-feed lubrication system
- Compact and lightweight
- High capacities

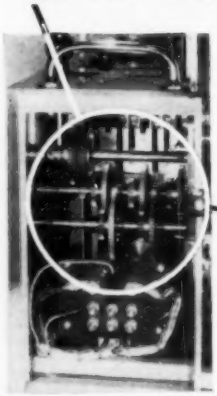
If you have any special problems — if you need any detailed information—please write us fully. You will receive a prompt and detailed reply.

KRAISSL CO. Inc.

297 Williams Ave., Hackensack, N. J.

Mass. G&T Gears

Applied in Biophysical Research Recorder



The Sanborn Company of Cambridge, Mass., manufacturer of the Poly-Viso Cardiette for biophysical research, is another of the many users of "Mass. Gears." This sensitive instrument calls for the application of gears of extreme precision, a requirement which is inherent in "Mass. Gear" production.

"Mass. Gear" is ready to assist you with your gear problems. Address: Massachusetts Gear & Tool Co., Woburn, Mass.

Massachusetts Gear & Tool Co.

IS THREAD STRIPPING YOUR PROBLEM?

Use

TAP-LOK INSERTS

for stronger-- durable threads

The Tap-Lok Insert greatly increases the strength of tapped threads in aluminum, plastics, wood and other materials of relatively low shearing strength. By enlarging the shear area it provides a firm anchorage for threaded fastenings of various types.

Installation is easy and rapid. A simple driving tool turns the insert into a cored or drilled hole equal in size to a tap drill hole for the external thread of the insert. It taps its own thread with the cutting edges of its slotted segments. The insert remains rigidly in place because the torque to dislodge it is greater than the torque a standard machine screw can withstand.

U. S. Patent 2,455,005

The Tap-Lok Insert eliminates the uncertainties, losses and weaknesses of molded-in and cast-in inserts — improves the product at lower costs.

Send for samples and descriptive folder.

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Also manufacturers of Groov-Pins—for positive locking press fit.

GROOV-PIN

GROOV-PIN CORPORATION

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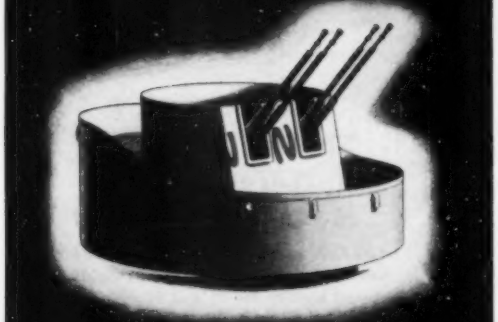
FOR *Coffee Makers?*



FOR *Conning Towers?*

With your firm—like all American Industry—facing the biggest job in history, here's something to remember as you move to handle both civilian and military requirements:

You can add extra engineers to your department to help with design problems—at no extra cost!

The services of experienced TK engineers are yours just for the asking. We pay their salaries and they usually stay in Chicago but they actually work for you. They're experts on electric heat. They should be! For we manufacture only electric heating elements and controls, concentrate all our research in this field. This specialization works to your advantage.

It means we can help with coffee makers, waffle bakers, flatirons, clothes dryers, sealing machines and boilers—everywhere and anywhere clean, safe electric heat is needed.

And—as we proved in World War II—it means that we're equally at home with heating elements for guns, gun directors, instrument panels, boat galleys and a host of other aircraft, marine and submarine applications. Thermocouples, sheathed wire, switches, controls and electrical components for modern ranges or for radar equipment also roll off our production lines.

Take advantage of TK "personalized" service. Call upon our engineers whenever you have a problem. Remember—they really work for you. For further information write TK—now.

TK *Heating Units*

TUTTLE & KIFT, INC. 1823 N. MONITOR AVE., CHICAGO 39, ILLINOIS
A SUBSIDIARY OF FERRO ENAMEL CORPORATION

MONOTUBE SURFACE UNITS • OVEN UNITS • TK INFINITE CONTROL • SWITCHES & SELECTORS • WATER HEATER UNITS • FLATIRON UNITS • INDUSTRIAL UNITS

NOW RESISTANCE SPOT WELDING

WITH this one welder you can weld the widely divergent metals listed above simply by changing control settings. Designed to weld aluminum to Army and Navy specifications, its ability to handle a wider range of thicknesses permits welding many aircraft components including primary structural members. Because it welds faster and will handle a wider range of work than any previous resistance welders, it produces at lower cost and can be amortized more quickly. Quality of welds is unsurpassed.

The patented Sciaky Three-Phase System uses up to 75% less current than single-phase welders and operates at approximately 85% power factor, making it practical even where power facilities are limited. Write for details today.

SCIAKY BROS., INC.
4913 W. 67th St.
Chicago 38, Illinois

NEW SCIAKY SERIES PMCO2ST Three-Phase Modu-Wave Welder

100 KVA at 50% duty cycle. 220 and 440 volt 3-phase 60 cycle standard. Available with special controls for 25 and 50 cycle current. Standard throat depths 36", 48" and 54". Welding range to MIL specifications (two thicknesses): aluminum and magnesium alloys .025" to .081".

SEND FOR BULLETIN

Complete details, description of controls, features, specifications are included in Bulletin 134-ST. SEND FOR YOUR COPY TODAY.

Mass production polishing with ELGIN DYMO

3 TIMES AS FAST!

This close-up view, taken in the McCormick Road plant of the Bell & Howell Company, Chicago, shows one station of a 12-head lens polishing machine specially converted for polishing hardened metal pressure plates. Exclusive properties of Elgin DYMO make this high production technique possible and assure fine, flawless finishes on this important part of the Bell & Howell projector mechanism.

ELGIN DYMO
diamond compound

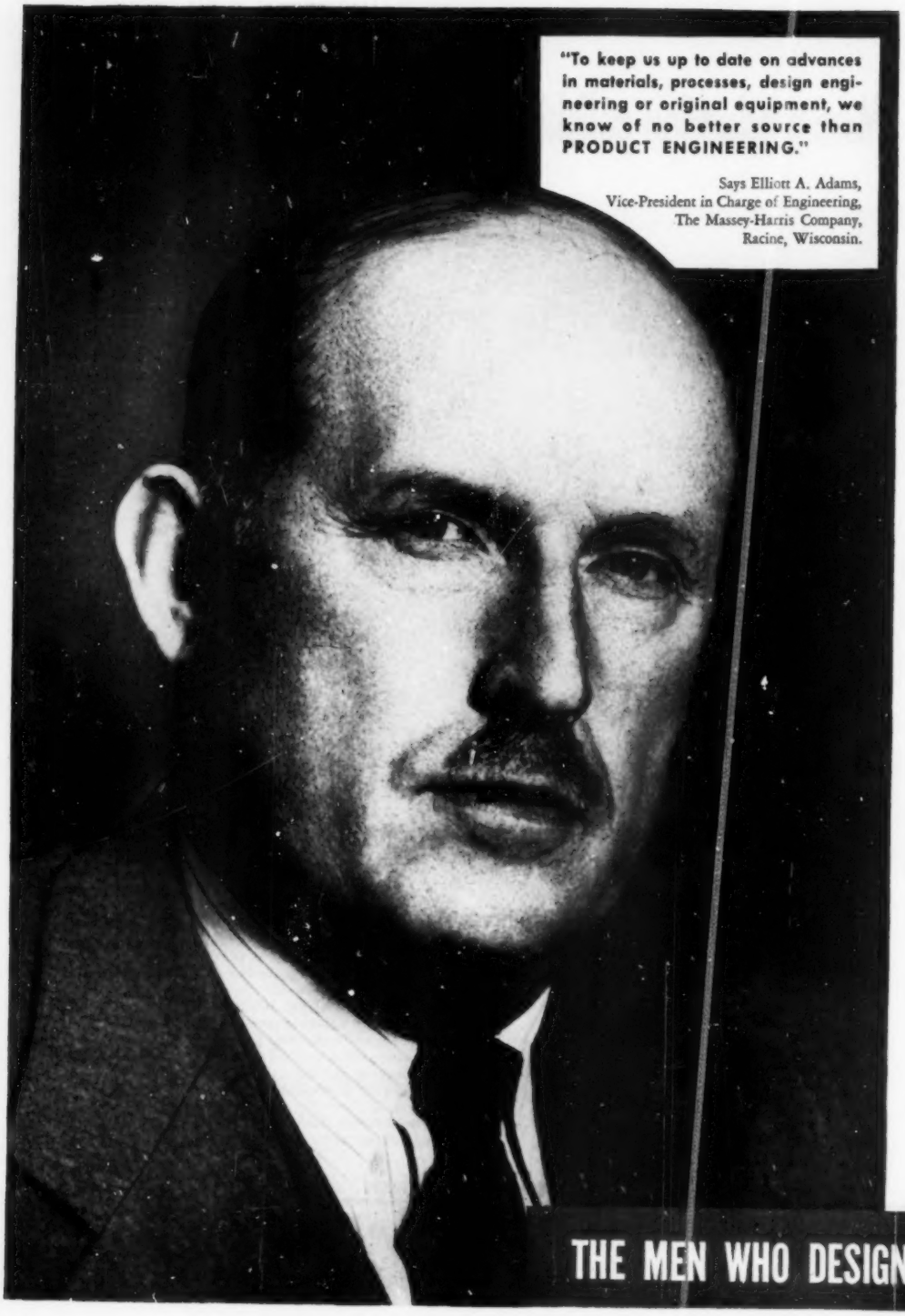
ELGIN DYMO
FOR FASTER FINISHING
FABRICATED SAPPHIRE
FOR WEAR RESISTANCE

Now you can have the fine finish quality that diamond offers and *faster production too* . . . with ELGIN DYMO Diamond Compound! Precision graded diamond particles are permanently suspended in an exclusive synthetic vehicle compounded to assure maximum cutting action and resistance to temperatures generated in machine lapping or polishing!

ELGIN DYMO, developed in the laboratories of the Elgin National Watch Company, is especially designed for *production* lapping and polishing, particularly of hard materials such as the carbides and tool steels. Try ELGIN DYMO for your carbide lapping, cutting tool polishing or mold finishing . . . write today for specific application data or a free demonstration right in your own plant! A full range of Bureau of Standards grades, each distinctly color identified, meets every finishing need.

Industrial Products Division
ELGIN NATIONAL WATCH COMPANY, ELGIN, ILLINOIS

ELGIN DYMO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Says Elliott A. Adams,
Vice-President in Charge of Engineering,
The Massey-Harris Company,
Racine, Wisconsin.
THE MEN WHO DESIGN

HE DESIGNS FARM MACHINERY...
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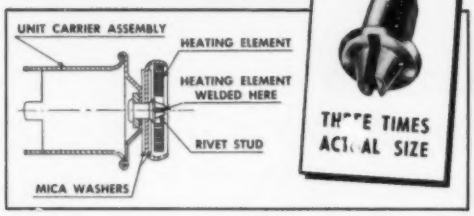
AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

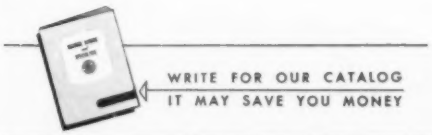
RUGGED LITTLE RIVET HAS TWO BIG JOBS



Small enough to put under your fingernail, this rivet is made by Progressive for The Cuno Engineering Corporation. Used in an automotive cigarette lighter, it serves as a post to which the center of the heating coil is spot welded and as a rivet for fastening the burner cup to the lighter shell.

This double function required precise upsetting of a metal sufficiently soft to be used as a rivet, yet rugged enough to withstand the welding operation.

At Progressive, we welcome special jobs like these. It's our business and we're good at it. See Progressive—if it's a SPECIAL.



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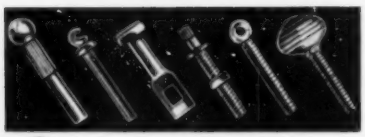

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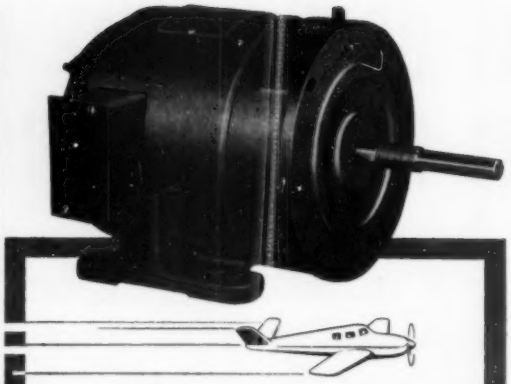

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ONE of the finest motor engineering staffs can be your motor department when you call on Peerless Electric.

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Peerless Electric motor engineering, noted for dependability and versatility since 1893, is as progressive as the modern age, and now, more than ever, available as the motor department of your business.

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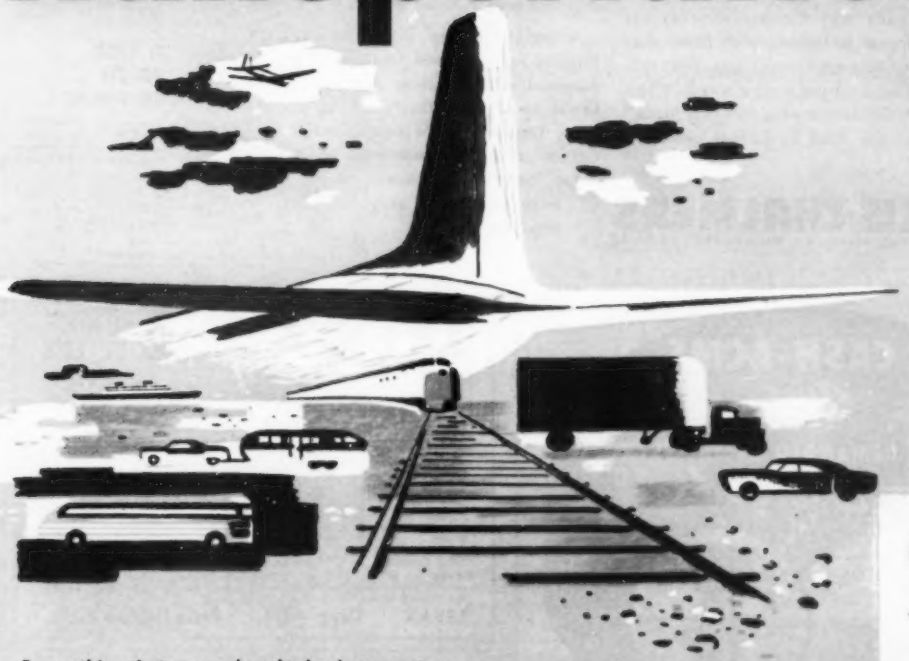
ALL *Peerless Motors* ARE "PEERLESS REGISTERED"

Van Huffel
cold-formed metal tubing and shapes
are proving their worth
in the vast field
of

transportation



In anything that moves, by wheel, wing or water, applications of Van Huffel metal tubing and shapes have become standard practice. Whether it is a frame for a modern trailer coach or an intricate part for a jet job, product engineers in the transportation field recognize the advantages in specifying Van Huffel whenever strength, style and simplicity . . . *plus economy* . . . are necessary characteristics of their products. Van Huffel means versatility.

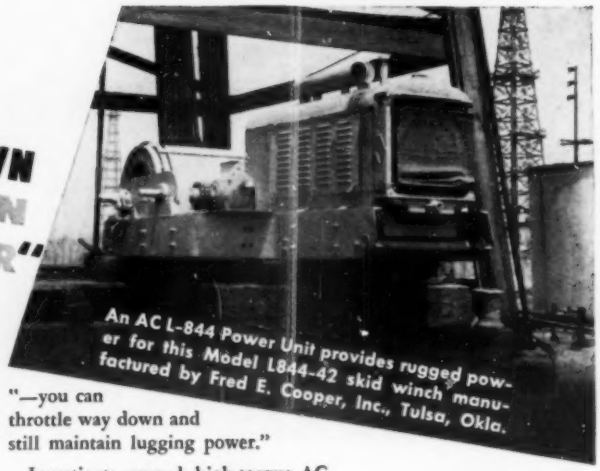
VAN HUFFEL

TUBE CORPORATION • WARREN, OHIO

WELDED, LOCK SEAM, OPEN SEAM, BUTTED TUBING, SHAPES AND MOULDINGS

AC Engines

"THROTTLE WAY DOWN and STILL MAINTAIN LUGGING POWER"



An AC L-844 Power Unit provides rugged power for this Model L844-42 skid winch manufactured by Fred E. Cooper, Inc., Tulsa, Okla.

. . . says Winch Manufacturer

Winches for servicing oil wells require rugged power—require engines that can pull thousands of pounds of pipe, hang onto heavy overloads like steam power.

That's why Cooper winches are equipped *exclusively* with heavy-duty Allis-Chalmers Power Units. They provide high torque at slow speeds. "This gives the necessary lug for heavy loads," states the Fred E. Cooper company, "—you can throttle way down and still maintain lugging power."

Investigate rugged, high-torque AC Engines for your own products. Production-line built, their first cost is low — so are operating cost and upkeep. Accessories to fit the application. Choice of fuels. Nation-wide service facilities. Let our power engineers help select the unit for your requirements.

A SIZE TO FIT YOUR NEEDS

MODEL*	R.P.M.	MAXIMUM BRAKE HP.
B-125	1500—1800	24.5—28.0
W-201	1400—1800	33.5—40.5
U-318	1200—1400	45.0—50.9
E-563	1050	74.0
L-844	1050	110.0

*figures represent cu. in. displacement

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TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

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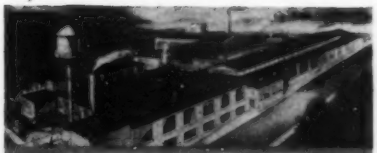
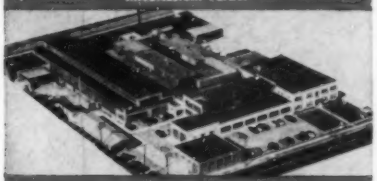


FAYETTEVILLE, NEW YORK

FAYETTEVILLE, NEW YORK
MAGNESIUM PLANT



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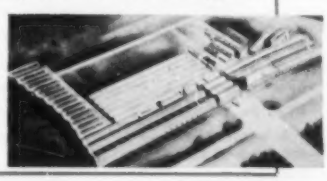

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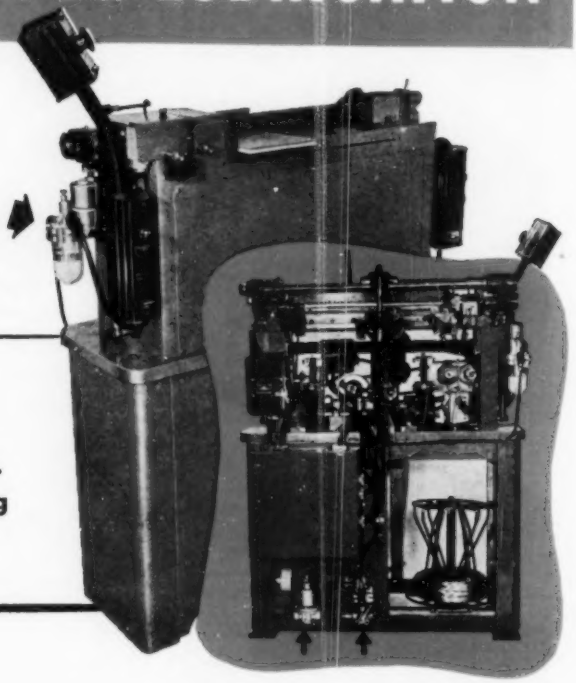
extends DIE LIFE many times!



and...

- Minimizes Flaking of Wire Coating
- Cleans Die of Flakings, etc.
- Cools Die to Safe Operating Temperature

If you have a die-lubricating problem, take a tip from Spiral Binding Company, New York—whose SB-6 machine won the Electrical Manufacturing 9th Annual Award for Product Design. This machine coils galvanized wire by means of a carbide die at a linear speed of 3,500 inches per minute.

When they started using a Norgren Oil-Fog Lubricator several years ago for die lubrication, they solved a tough engineering problem. By lubricating the die with an air borne oil fog from a Norgren Lubricator they found they produced five important advantages: 1) Greatly increased die life, 2) Reduced to a minimum the flaking of wire coating, 3) Kept die free of flakes and other foreign matter, 4) Maintained temperature of the die at a safe operating level, 5) Provided these advantages without danger of staining the paper to which spiral binding was applied.

Two air cylinders on the machine—one for aligning holes for the spiral wire; the other for wire cutting operation—are both served by a Norgren Regulator-Lubricator Unit for controlled air pressure and positive lubrication.

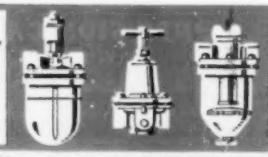
The total result, says Chief Engineer M. H. November, is "top performance of our machine at negligible maintenance charges...over millions of cycles of operation."

For full details, write for **APPLICATION DATA SHEET No. 106**

C. A. Norgren Co., 228 Santa Fe Drive, Denver 9, Colo.

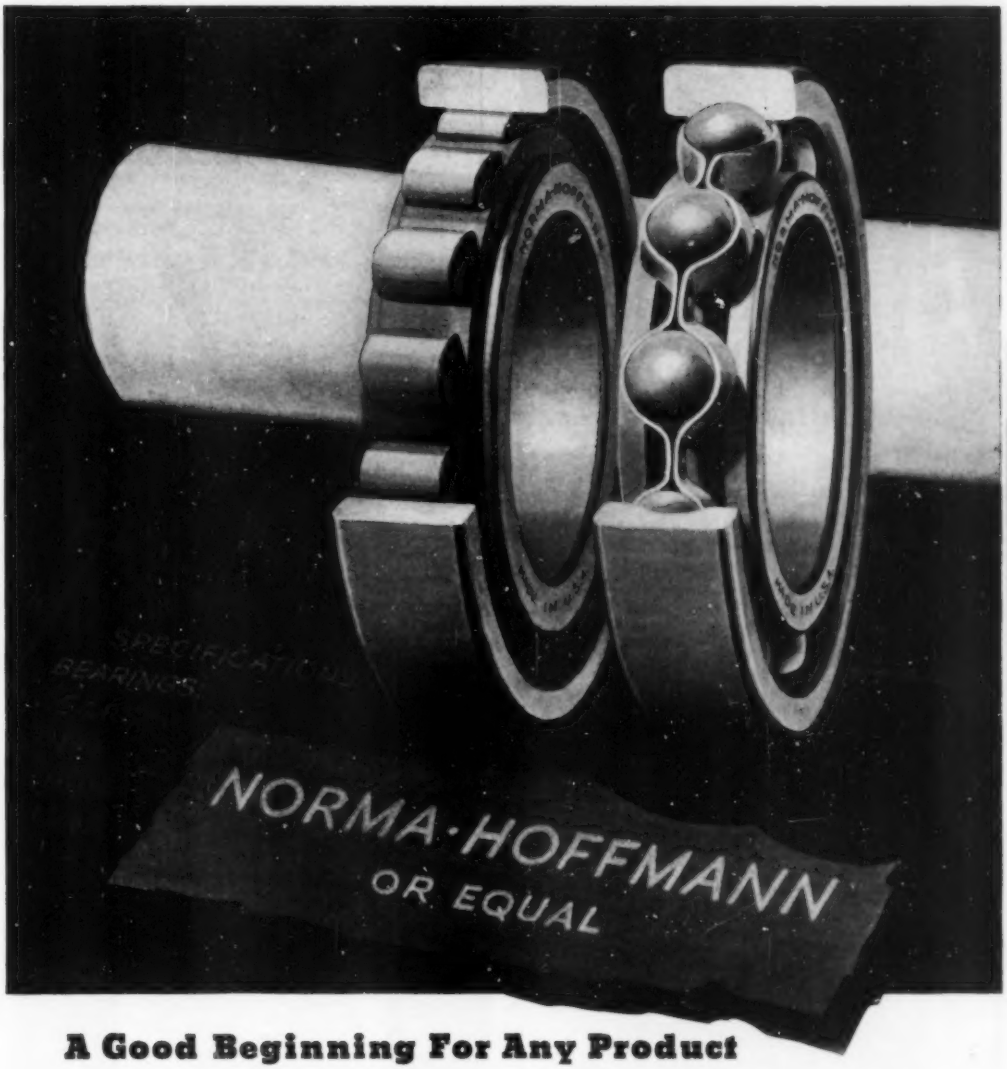
25th Year of Progress

Norgren



Lubricators, Regulators, Filters, Relief Valves, Check Valves, Air Governors, Needle Valves, Hose Assemblies and Couplings.

25 YEARS OF HELPING AIR POWER SERVE INDUSTRY BETTER



A Good Beginning For Any Product

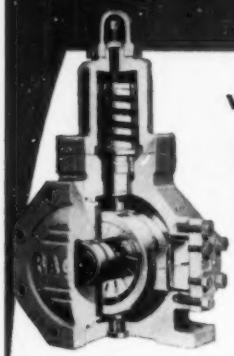
Here's why "Norma-Hoffmann or equal" is found on thousands of blueprints embracing all types of equipment. It results from designers' preference for bearings that have earned a reputation over the past 30 years for *precision* and *quality*.

And with good reason! These bearings provide ruggedness, dependability, long life and low upkeep. They assure minimum cost per bearing-year of service. Their accuracy and built-in high antifriction characteristics improve product performance. While the wide range of choice . . . 108 distinct series, over 3,000 sizes . . . makes selection easy.

NORMA-HOFFMANN
Precision
BEARINGS
BALL · ROLLER · THRUST

PAGES
MISSING

FULL VOLUME
HIGH PRESSURE
. . . BUT LOW HORSEPOWER

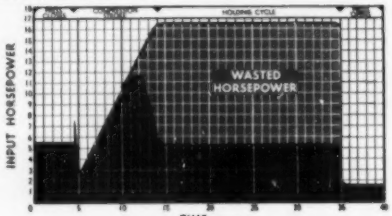


with
RACINE
Hydraulic
PUMPS

High pressure holding is economical with RACINE Variable Volume Pumps. They will automatically cease their pumping action but maintain full pressure in the system. Instant change from no volume to full volume insures smooth, sure application of hydraulic force. Horsepower requirements are measured by the actual needs of the job — all of the oil is put to work.

RACINE Variable Volume Pumps eliminate the need for relief valves — reduce oil heating — save horsepower and lower the over-all cost of most circuits.

Various standard governors are available for RACINE Pumps. These governors develop the pumping action that will best handle special requirements of the circuit. Maximum efficiency is assured.



The graph above illustrates the horsepower savings in a simple press circuit using a RACINE *Variable Volume Pump and Pressure Booster. The area in blue represents the bypassed oil from a constant volume pump — lost power that is saved with* RACINE *Equipment.*

Write for complete catalog and engineering data.

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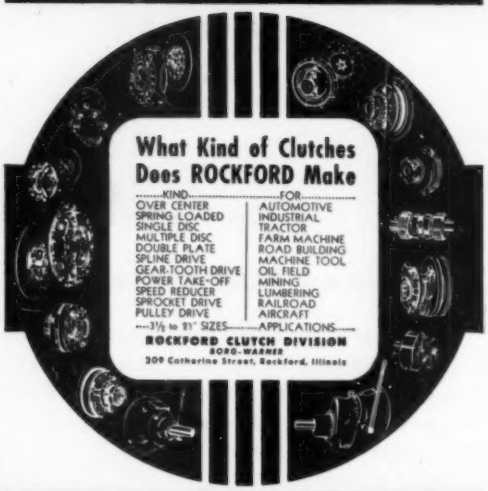
CONTROL POWER BETTER



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Security—Nearly all of the engineers who joined us in World War II are still with us, and in the past 10 years our total employment has almost doubled. These are not temporary jobs.

Participation in the Defense Effort—In 1951, a large part of all Westinghouse production will be to satisfy the nation's military needs.

Minimum Experience Required—2 years . . . but some of these openings call for top-flight men with more experience.

Salaries—Determined individually on the basis of the experience and ability of the applicant.

Location—There are openings for engineers, metallurgists, physicists, and chemists at most of Westinghouse's 36 plants. For example: you'll find opportunities to do jet engine work at Kansas City, Missouri and South Philadelphia, Pa. . . . in Ordnance manufacturing at Sunnyvale, California and Sharon, Pa. . . . on atomic power projects in Pittsburgh, Pa. . . . in radar and electronics at Baltimore, Md. . . . in aircraft equipment and fractional horsepower motors at Lima, Ohio . . . and in commercial and airport lighting at Cleveland, Ohio . . . and in power producing equipment to speed the production lines of America. And all of these activities have a definite and established peacetime application.

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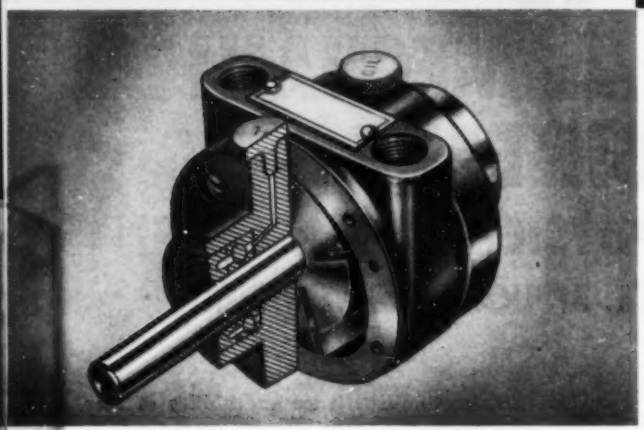


- *to simplify design*
- *to reduce costs*
- *to improve performance*

GAST rotary-vane design has many advantages . . .

1. No piston rings—no hinged parts, rockers, counterweights, reciprocating parts, etc., to wear out or require adjustment.
2. Air delivery is continuous and pulseless.
3. A rotor and four sliding vanes are the only moving parts.
4. Centrifugal force holds vanes tightly against housing for an efficient, uniform seal.
5. Vanes take up their own wear automatically.
6. Forced air fan cooling insures long life, oil economy, no hot-oil odor.
7. Automatic oiling insures continuous lubrication, minimum wear.
8. Automatic shaft seal requires no packing.
9. Rugged bearings insure long life.
10. Greater reliability, less maintenance, lower first cost.

NEW Model 8 AM ROTARY AIR MOTOR
½ to 4 h.p.—6 types

Any one of the 6 design variations can be ordered to suit your application. Reversible and non-reversible models. The reversible motor is ideal for frequent stop-and-start applications in slower speed ranges. The non-reversible rotates counterclockwise. May be operated above 2000 r.p.m., delivering up to 4 h.p.

Here's how GAST rotaries deliver valuable benefits as original equipment on your products . . .

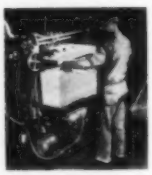
First, you stand to benefit from Gast's background of experience (over 25 years of it) in engineering Gast Rotaries for use on hundreds of different product applications. In addition, the basic simplicity of Gast rotary-vane design delivers unique performance advantages with efficiency and dependability. Then, because our customers have built a large demand for models **you** may want to use, costs are lower on a choice of over 200 different assembly models. Air power, air pressure or vacuum in the lower capacity ranges may give you specific worth-while advantages over mechanical, electrical or hydraulic methods of doing your product job. Get the complete story—"Air may be your Answer!"

GAST rotary air motors are compact, explosion-proof, variable in speed

On this Bede Circulating Paint Heater, designed for faster application of hot finish, a Gast Air Motor running below 500 r.p.m. drives liquid pump. It's explosion-proof and safe—uses less than 30 p.s.i. air pressure.

On this Conveyor-Belt carrying fragile material, a variable-speed 1 h.p. Gast Air Motor automatically reduces speed, compensating for uneven drag of load to maintain constant tension on material in process. Over-loads can't burn out a Gast!

GAST rotary air pumps for pulseless pressure to 30 lbs., vacuum to 28 in.



On offset printing presses, vacuum-back cameras, and lithographer's printing frames, American Type Founders use several sizes of Gast Air Pumps for paper-feeding (both suction and air blast) and copy holding (suction only).

To remove aluminum bottle caps from magazine and hold ready for feeding, Aluma-SEAL specifies a positive-action Gast Air Pump producing 20 to 22 inches vacuum for feeding its bottle capping unit.

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See our CATALOG in SWEET'S FILE

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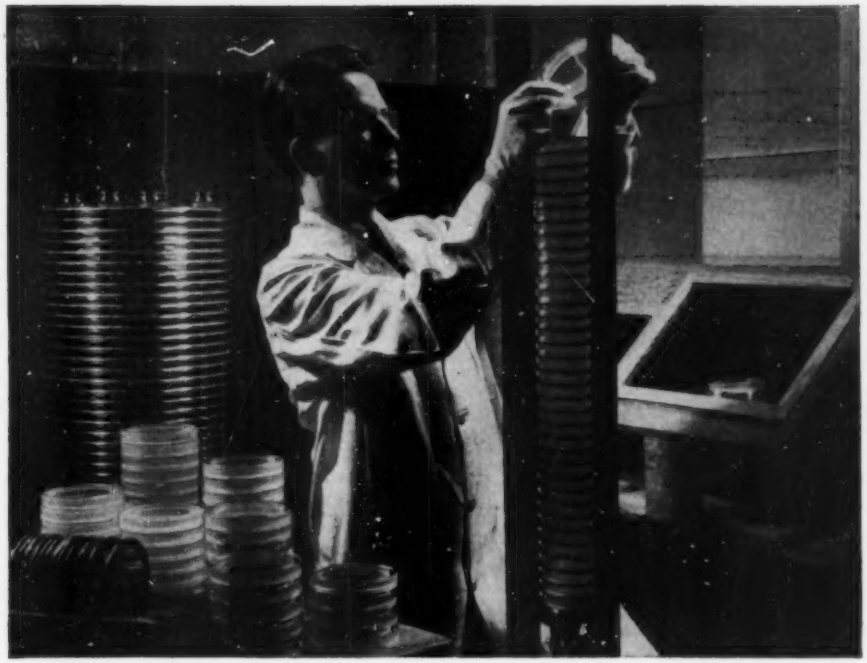

HOW ENGINEERS STACK THE DECK ... AGAINST TWO MILLION VOLTS

When you have millions of volts driving electrons through a tube you have a tough insulating problem on your hands. High Voltage Engineering Corporation faced just such a problem in designing the heart of a Van de Graaff generator for super voltage X-rays and for accelerating electrons used in sterilizing drugs and food.

The problem was to find an insulating material that would withstand long periods of electron bombardment . . . one with electrical characteristics which were *known* and *uniform*. To be able to carry through on their approach they needed insulating rings with high dielectric strength, low loss factor and high volume resistivity.

In the photograph above you see the answer. High Voltage engineers found precision-made special glass rings by Corning . . . glass specifically designed to maintain over long periods the right balance of properties and to keep the Van de Graaff generator at peak efficiency.

In this way Corning has helped bring to industry and medicine deep X-rays and high velocity electrons heretofore available only to heavily endowed research laboratories. By assisting in the development of new products, Corning has helped many engineers get off on the right foot. That is a specialty with us.

Corning is constantly developing new types and finding new uses for glass. Perhaps you're working on a new idea, possibly the transmutation of elements . . . or it may be that you've had difficulty in obtaining scarce materials. It will pay you to investigate glass. You'll find that at Corning, *glass is economical and available now*. Write today for Bulletins B-83 and B-84.

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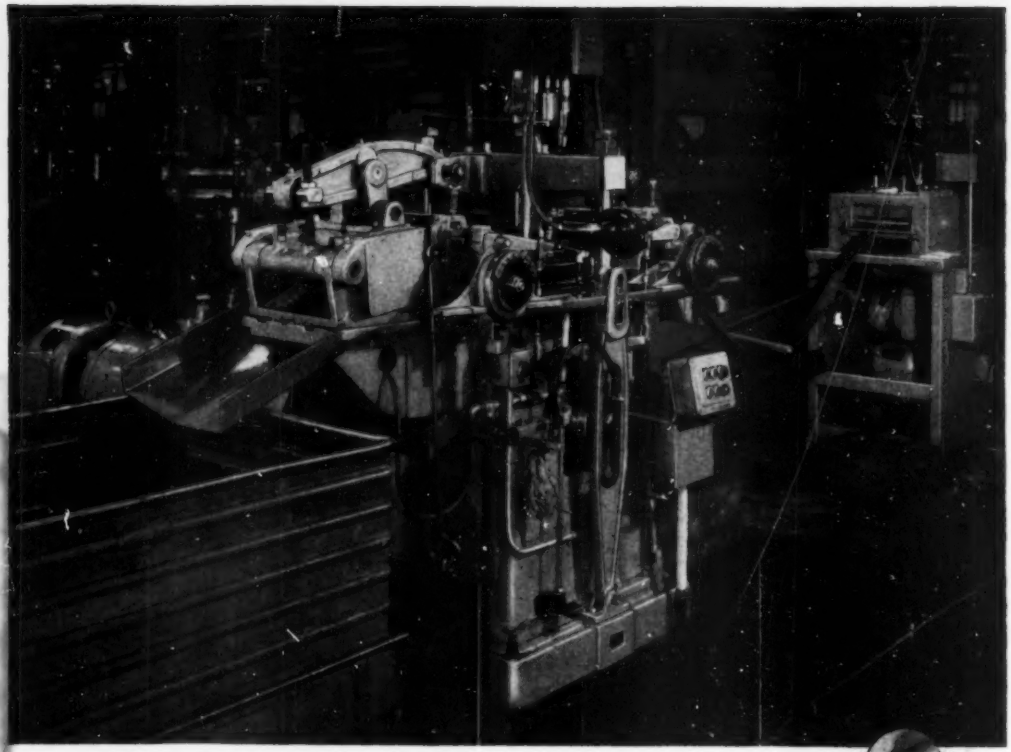

For National Cash Register which uses three sizes of Henry & Wright Dieing Machines to produce 310 different parts. Production rates range from 400 strokes per minute on a 25-ton machine to 80 strokes per minute on a 75-ton machine, with one or more completed parts produced per stroke. You can't beat them for long die life, or versatility. Remember this: because of their unique, revolutionary design, only Henry & Wright Dieing Machines give you both high speed and long die life. It's an unbeatable combination.

Only the best is

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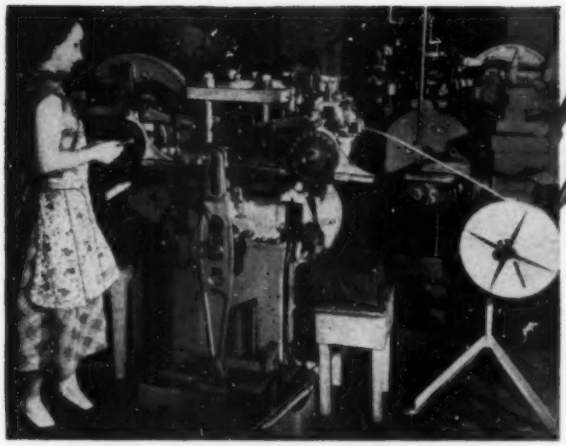
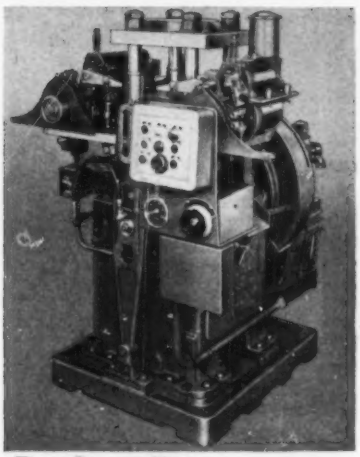
PLASTIC BOTTLES, RODS, TUBES, SPECIAL SHAPES

PLAX CORPORATION
Subsidiary of Emhart Mfg. Co.
HARTFORD 1, CONNECTICUT

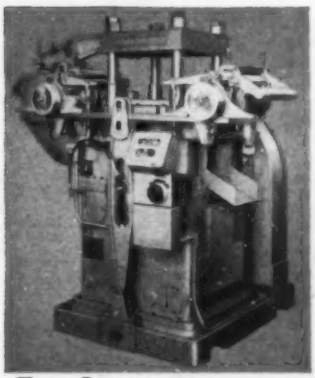


For The Esterbrook Pen

Company which, from the start, has used H. & W. Dieing Machines to produce a wide variety of components for its modern line of fountain pens. Esterbrook selected H. & W. Dieing Machines because of rigidity of lower platen and four-post guide — and their versatility. Stainless steel clips shown here are produced in combination dies which blank, form and mark.



For Link-Belt Company, which uses Henry & Wright Dieing Machines to produce parts for power transmission chain. Here is additional proof that you can depend upon H. & W. machines for speed, precision and sustained efficiency in the production of metal stampings.



For Addressograph-Multigraph

Corporation where complete-per-stroke production on Henry & Wright Dieing Machines keeps production rates high and costs low. Leading companies know they can get the performance they need with Henry & Wright machines.

good enough

FACT PACKED CATALOG
Complete descriptions of all Henry & Wright Dieing Machines. Write: Henry & Wright, 992 Windsor St., Hartford 5, Conn.

Henry and Wright

H&W

HENRY & WRIGHT
Division of Emhart Mfg. Co.

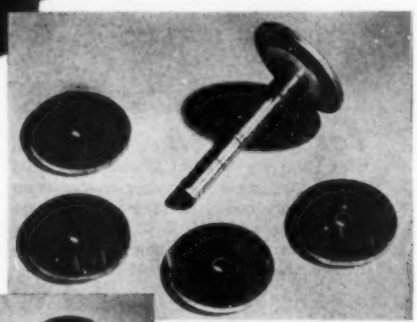
What's U.S. Rubber doing for electrical design?

Transformer handle made of Enrup for a large manufacturer of electrical equipment. Enrup was selected because its electrical properties can be maintained under very adverse conditions, and because it has great toughness, impact strength, and resistance to other solvents. Enrup has been so successful that the manufacturer intends to use it for other phases of transformer design and construction.

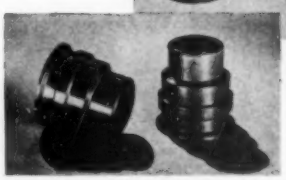
The horizons of electrical design are being widened by U.S. Rubber's new thermosetting plastic, Enrup. The transformer handle shown here has greater strength and electrical properties because it is made of Enrup.

This remarkably versatile substance can be punched, sanded, sawed, nailed, bolted, molded or machined. Enrup can be made into almost any shape or form, simple or complex. It may be exactly what you have been looking for to make your product stronger, more efficient, less expensive.

Enrup is fabricated and molded entirely by U.S. Rubber engineers. They will gladly discuss your particular problems. Write to address below.



Pump valve seat made of Enrup because Enrup resists swelling or deterioration caused by gasoline, and because it resists compression set or deformation over a wide range of temperature conditions.



This printing roll-end bearing demonstrates Enrup's high adaptability to precision molding techniques. It has high dimensional stability and resistance to corrosion caused by photographic solutions.

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SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Do You Know?

YOU CAN CHANGE SPEEDS
IN A RATIO OF 7200:1 IN A SPACE OF ABOUT 2 CU. IN. WITH A **TELECHRON** SEALED, SELF-OILING GEAR TRAIN... IF YOUR OUTPUT SHAFT LOAD DOES NOT EXCEED .375 POUND INCHES?

216,000 TO 1

SPECIAL GEAR TRAINS
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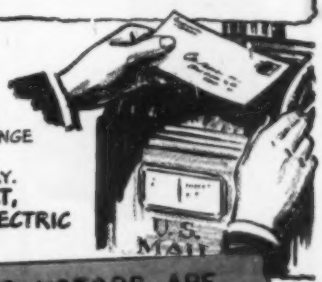
BY RETURN MAIL,
YOU CAN GET DATA AND ESTIMATED QUANTITY PRICES ON **TELECHRON** GEAR TRAINS IN STANDARD SPEED-CHANGE RATIOS RANGING FROM 7200:1 TO 25:1. WRITE FOR THE FACTS TODAY. **TELECHRON INC. 15 UNION STREET, ASHLAND, MASS. A GENERAL ELECTRIC AFFILIATE.**



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ALL TELECHRON TIMING MOTORS ARE INSTANTLY...CONSTANTLY SYNCHRONOUS

The Standard For Industry
For More Than 40 Years
Gits Oil Cups Have
Proved Dependable and Superior
in Thousands of Installations

Now! Used Throughout Industry!

GITS *Unit* SEAL

Has *Proved* Dependable and Superior in Actual Use

. . . in standard aircraft

. . . in jet aircraft

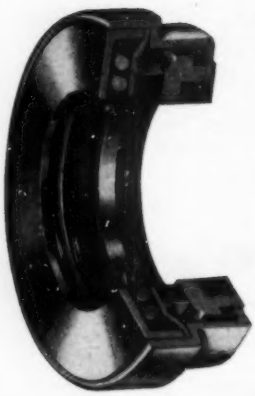
. . . in tanks

. . . in motor trucks

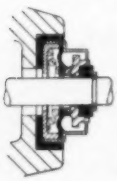
. . . in scores of other important applications

It is "engineering wise" to specify the Gits Unit Seal on your blueprints. Here's why:

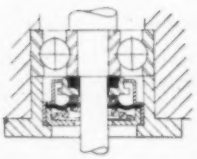
- Simply installed—eliminates possibility of damage to the seal faces during installation—a production line advantage to the user
- Designed to use minimum diametrical and axial space consistent with good engineering principles
- Adaptable to pressure applications when correctly engineered into the product



Here are two typical GITS UNIT SEAL installations:



1. Synthetic rubber gasket holds Gits Unit Seal in position. Shaft shoulder forms backing for Rotating Seal Face.



2. Gits Unit Seal pressed into adapter plate. Rotating Seal Ring butts against bearing race for backing.

To start on your *own* road to better sealing . . .

Write Now for FREE Illustrated Brochure

or send your seal problems to Gits Bros. engineers for their recommendations

GITS BROS. MFG. CO.

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- ☐ 128-B Split-Phase
- ☐ 128-C Integral
- ☐ 128-D Fan-Duty
- ☐ 128-E Oil-Burner
- ☐ 128-F Jet Pump
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die castings
THE HOOVER COMPANY
die castings at a glance
how die castings are made
hints for designing good die castings

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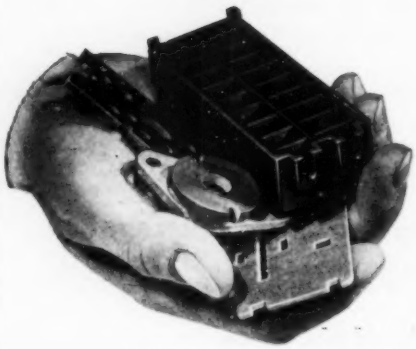
The RICHARDSON COMPANY
FOR HELP ON PLASTICS
FOR YOUR DEFENSE ORDERS



● If you have a puzzling plastics problem, consult The Richardson Company. The extensive services of its research, design, and engineering departments are offered you without cost or obligation.

Richardson engineers have a broad background in the plastics industry. For many years they have been co-operating with manufacturers in the selection or development of the correct plastics materials, choice of the proper manufacturing process, and actual production of the plastics part. Richardson's molding, laminating, and fabricating experience assure you a thorough handling of your plastics problem from beginning to end.

1 MATERIALS TO MEET GOVERNMENT REQUIREMENTS

The Richardson Company has extensive experience in the volume production of materials made to meet government requirements. In addition, Richardson develops new materials for special applications.

2 FACILITIES FOR MOLDING AND LAMINATING

Richardson is one of the few companies that have the engineering experience and production facilities to do both molding and laminating, and to produce molded laminates and post-formed laminates.

3 SIX PLANT LOCATIONS

The Richardson Company operates large, modern plants at 6 widely separated locations: Melrose Park, Ill.; Indianapolis, Ind.; Newnan, Ga.; New Brunswick, N. J.; Tyler, Tex.; and Ogden, Utah.

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FOUNDED 1858—LOCKLAND, OHIO

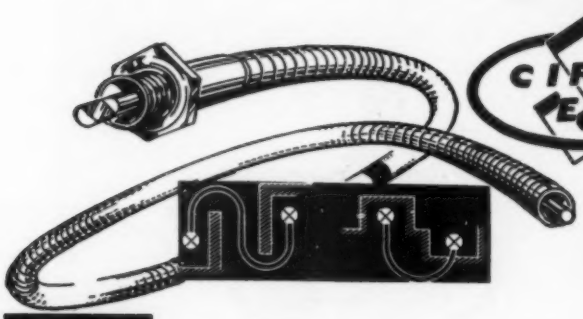
2793 Lake St., Melrose Park, Illinois (Chicago District)

INSUROK
Laminated and Molded Plastics

SALES OFFICES: Cleveland • Detroit • Indianapolis • Lockland, Ohio • Los Angeles
Milwaukee • New Brunswick, (N. J.) • New York • Philadelphia • Rochester • St. Louis

REDUCE YOUR NUMBER OF PARTS

and Permit a Logical Grouping of Working Units



Flexible
SHAFT ASSEMBLIES

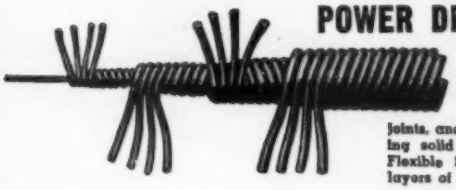
Due to our wide experience in developing flexible shafts for carrying power around any corner, we can give you immediate help in solving your alignment problem. Circle Ess Flexible Shafts are today serving in the machinery, electronics, automotive, and aircraft industries where, in numerous cases, many new problems were solved.

FLEXIBLE SHAFTING MADE IN STANDARD SIZES AND TO YOUR SPECIFICATIONS

It is not necessary for you to use expensive arrangements of mitre gears, universal joints, spur gears, and other space wasting constructions. The answer to simplified arrangement, inexpensive, efficient performance, is in the transmittal of power around bends with Circle Ess Flexible Shafts.

Mechanical and electrical controls may be placed in a position for economical yet highly efficient construction and still be operated from a readily accessible point through use of a flexible shaft assembly.

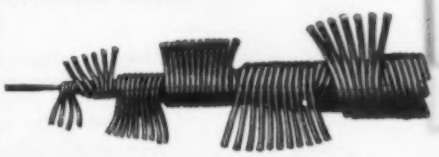
POWER DRIVE SHAFT



This shaft is used in transferring power around corners and under or over necessary obstacles. It has many advantages over the solid shaft—it eliminates mitre gears, bevel gears, universal joints, and the costly production time that is spent in aligning solid shafts. Pictured is a section of Power Drive Flexible Shafting showing construction of superimposed layers of wire wound in opposite directions.

REMOTE CONTROL SHAFTS

This type is used when a driven element needs to be moved only a fraction of a turn or several complete turns. Also used when it is necessary to both rotate and reciprocate, such as the opening and closing of valves. The designer is free to place the controls of a product in a position that is centrally located and accessible. Picture shows construction of superimposed layers of wire wound in opposite directions.



OUR ENGINEERING DEPARTMENT *is at Your Service*

We wish to extend to every plant executive and plant engineer, the facilities of our engineering department so that they may have the full use and benefit of the vast amount of practical Circle Ess data which has been compiled over many years. Our engineers, with specialized experience, are ready to help you in selecting the proper material for your needs and should it be necessary, our complete laboratory facilities are available to test your equipment to obtain design data.

Write for our booklet "FLEXIBLE SHAFT ASSEMBLIES"

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F. W. STEWART MFG. CORPORATION

4311-13 RAVENSWOOD AVE. CHICAGO 13, ILL.

WEST COAST BRANCH: 431 VENICE BLVD. LOS ANGELES 15, CAL.

It has valuable information for all industries where power drives or remote control are required.

MADISON-KIPP DIE CASTINGS

* Hardened Steel Insert for Wear

Die Casting for Special Shape and Contour

The exact die casting here illustrated may not apply to your design but it may give you a valuable idea for future use.

Madison-Kipp has developed a great many insert jobs for ordnance and commercial parts that have solved pressing problems.

When you have die casting requirements, please remember to write Madison-Kipp at Madison, Wisconsin.

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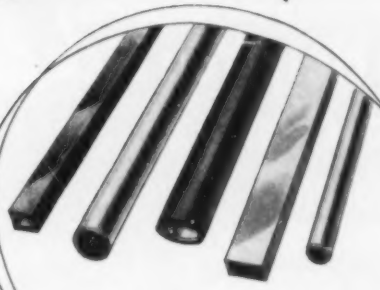
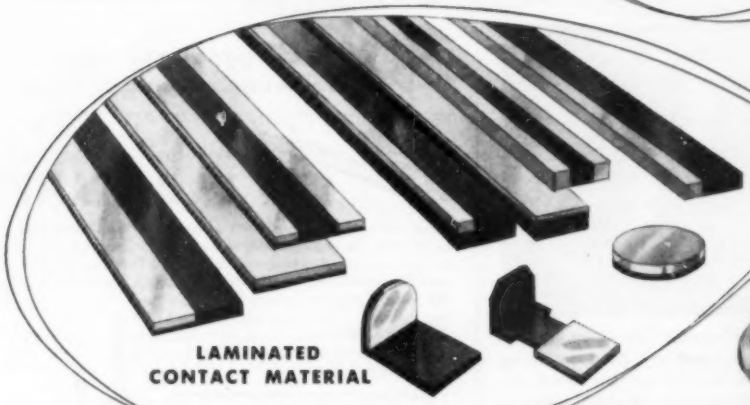
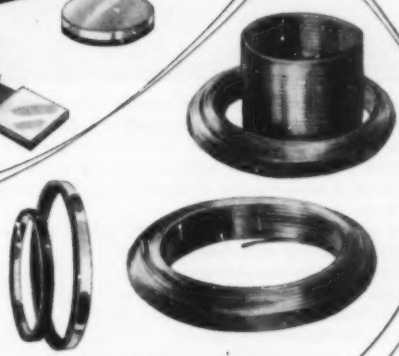


LAMINATED TUBES



LAMINATED CONTACT MATERIAL



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"UNION" laminated metals provide you with economical solutions to electrical and electronic contact problems. Our metallurgists and technicians will be glad to work with you. Just write us.

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Cut the cost of dies
Gain weeks of time

Spincraft
SKILL WILL DO IT

spinning and fabricating
can Help You Lick Production Problems

Bellmouth for testing jet engines spun and fabricated of stainless steel.

HIGH tooling costs — months of waiting time — the urgency of the hour — these very real conditions need not bring despair to able designers and alert production executives. Spincraft engineering may well provide you with a welcome solution at a small fraction of conventional fabricating costs and in far less time.

The parts or products you see here reflect what can be done by spinning and fabricating in combination. This resourceful approach provides a wide range of opportunities in many metals that you are invited to discuss with Spincraft engineers. The answer you want cannot be guaranteed, but others have been helped so often and so well that Spincraft has become the world's largest metal spinning and fabricating plant. Call or write

Send for the Spincraft Data Book—40 pages of engineering information that will be helpful to you.

Spincraft
SKILL WILL DO IT
INCORPORATED

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Heretofore known as Milwaukee Metal Spinning Co.

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DISCOVER MIRACLE-WORKING
KELLER
MOLDED PLYWOOD

Keller designed to improve . . .

Keller engineered to meet requirements . . .

Keller fabricated . . . hundreds of new molded plywood products and metal substitutes during World War II.

Prime Contractors: You may have problems of metal shortages where molded plywood has proven an ideal substitute. You may have production facility limitations or shortages.

Turn to Keller—for design, engineering and fabrication of molded plywood from very light to heavy gauge shapes in nearly any practical size, gauge and veneer. Low pressure plastic impregnated cloth. Laminates of light metal to wood, fibre glass, foam plastics, rubber base and composition materials.

Keller PRODUCTS, INC.
53 UNION STREET, MANCHESTER, NEW HAMPSHIRE

Announcing NEW CAM CLAMPS

These cam-action clamps were designed for applications where parts (such as castings, larger forgings, or stacked stampings) having variable thickness, are to be held. They are the only big cam clamps known that provide convenient means for locating the spindle assembly along the toggle bar.
The spindle itself is easily adjusted for clamping height, and can be replaced by a special pressure pad to suit other clamping requirements.

MODEL CAV-1200
Recommended force at end of toggle bar. 1200 lbs. Recommended force 3⅛" from front of base, 1900 lbs.

MODEL CAS-1200
This clamp has the additional advantage of permitting the toggle bar to be swiveled around the base to any position within 180°

MODEL CAS-2000
This clamp has the same features as Model CAS-1200, but for 2000 lbs. clamping force.

MODEL CAV-2000—similar to above but has fixed base.

This entire series is also available without cam action (with fixed locking). Catalogued as Models V-1200, S-1200, V-2000, and S-2000. Complete catalog sent on request.

KNU-VISE PRODUCTS
LAPEER MFG. CO.
3058 DAVISON ROAD • LAPEER, MICHIGAN

WESTERN DIVISION: 422 MAGNOLIA ST. GLENDALE, CALIF.

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The finish on *any* military equipment is all-important for effectiveness in combat—that is why government finishes "specs" are a problem for the manufacturer with Defense orders. ZAPON can help!

ZAPON not only provides finishes that conform to "specs"—our Customer Service department will help set up your finishing department to fulfill government contracts with speed and economy. This is ZAPON Service From Every Angle.

Service from every angle... that's ZAPON

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Industrial Finishes

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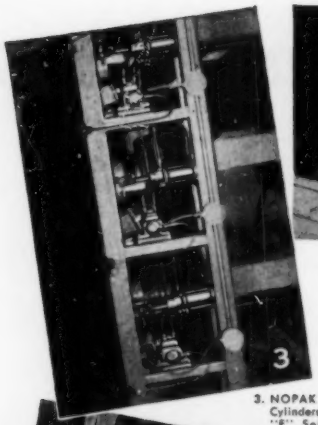
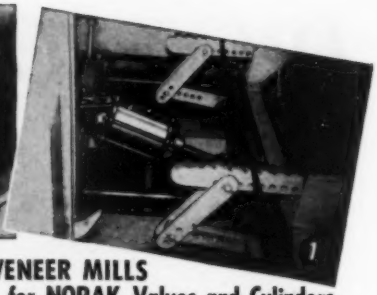
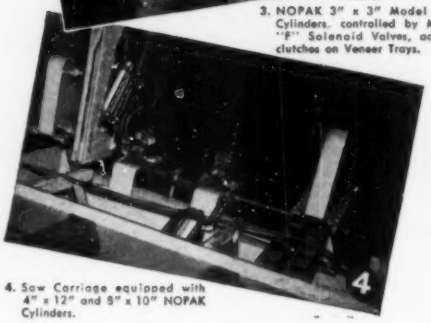




1. Cant Flipper actuated by NOPAK Model "E" Cylinder.
2. Log Deck Flipper-Arm Set-Up operated by 6" x 18" Model "E" Cylinder controlled by NOPAK Model "R" Foot Valve.
3. NOPAK 3" x 3" Model "E" Cylinders, controlled by Model "P" Solenoid Valves, actuate clutches on Veneer Trays.



4. Saw Carriage equipped with 4" x 12" and 9" x 10" NOPAK Cylinders.

LUMBER and VENEER MILLS
Find Many Uses for NOPAK Valves and Cylinders

The four applications pictured here are typical of hundreds now in operation in the lumber and wood products industries. Lifting, tilting, pushing, pulling and clamping operations are readily simplified and accelerated through proper application of NOPAK Valves and Cylinders of the correct size and type.

In modernizing machines or equipment which you use in your own plant, or build for others, consider the advantages of using Air or Hydraulic Power the NOPAK way. For data and descriptions, refer to Sweet's File for Product Designers, or write for Bulletin SW-1.

GALLAND-HENNING MFG. CO., 2762 S. 31st Street, Milwaukee 46, Wis.

Representatives in Principal Cities

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE
A 5913-½H-A

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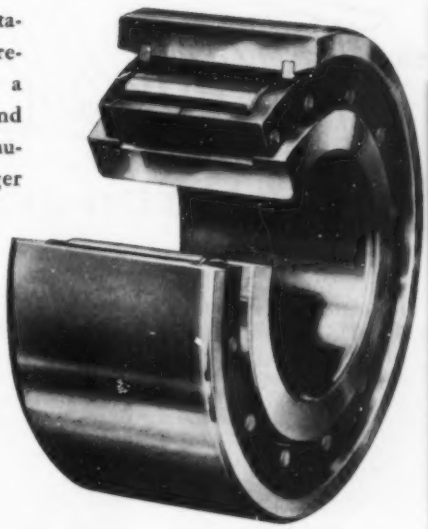

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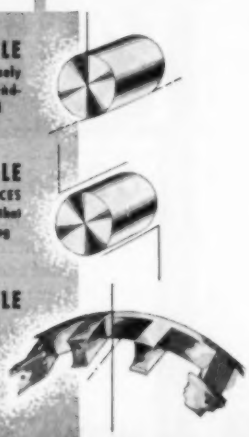

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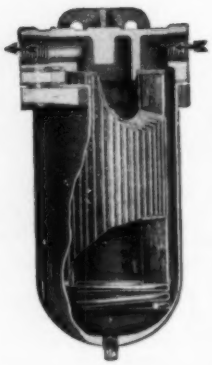

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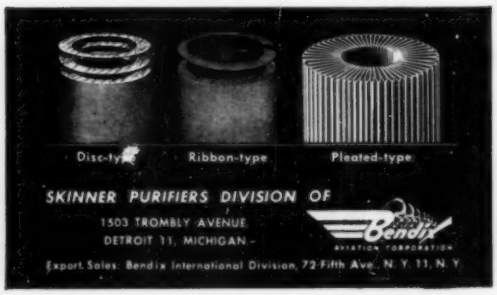

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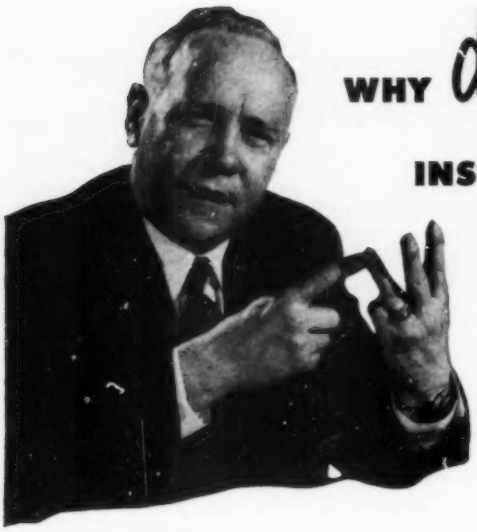

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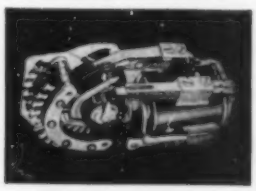

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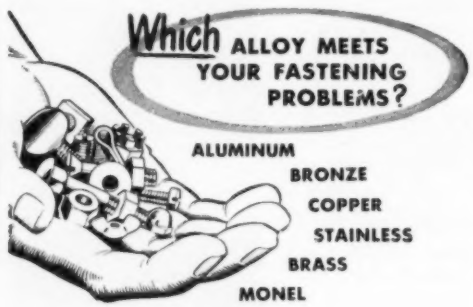

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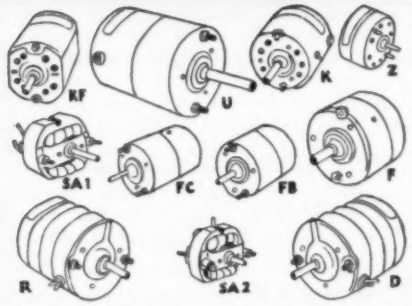

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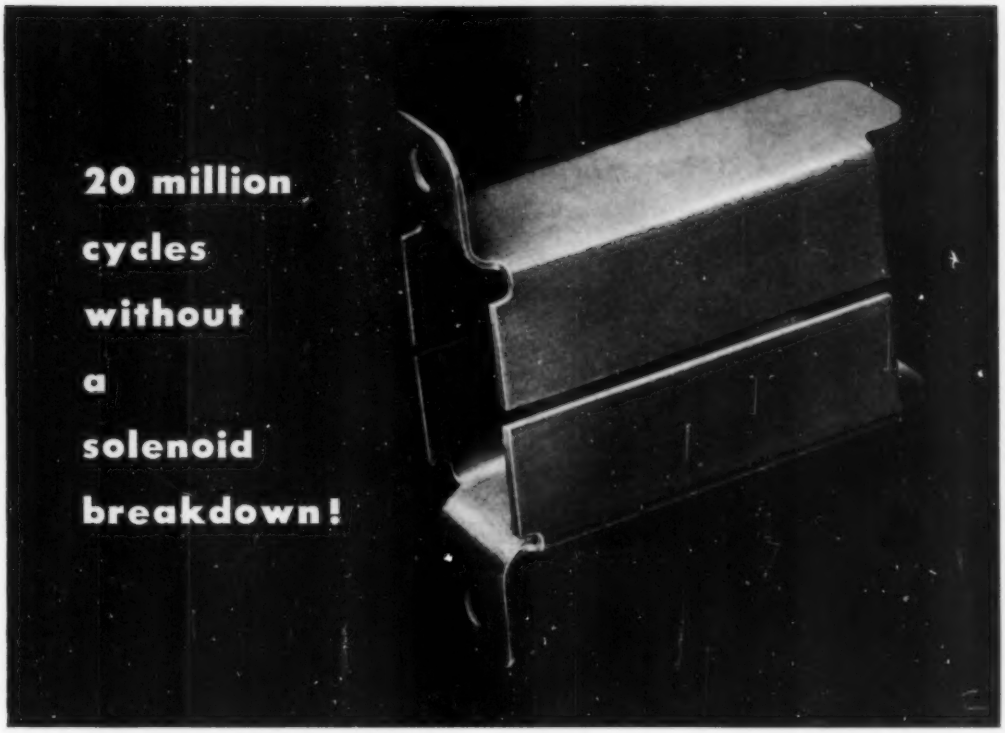

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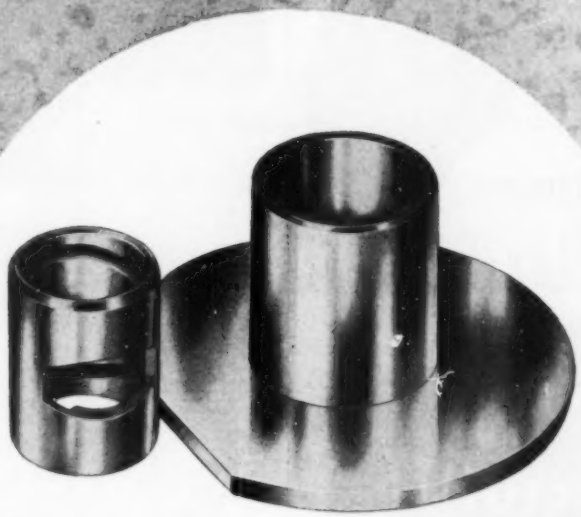

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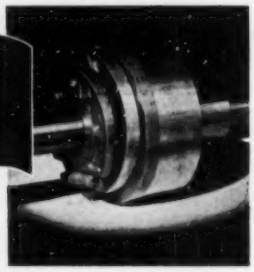

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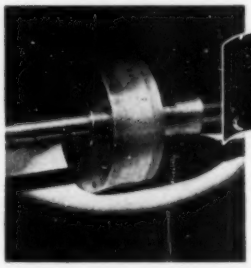

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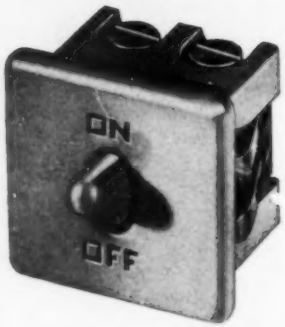

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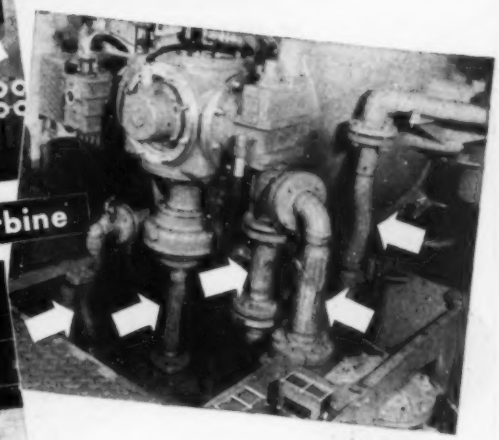

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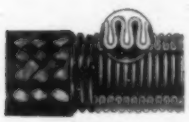

REX-WELD corrugated steel and bronze hose is available in standard sizes from ¾" through 12" I.D. for burst pressures to 12,000 psi, temperatures to 1000° F. Stainless steel types also available.

REX-TUBE convoluted hose is available in a variety of types including square locked, ball bearing and fully interlocked in a variety of metals including steel, bronze and other alloys.

Flexon identifies CMH products that have served industry for over 49 years.

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for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems
Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

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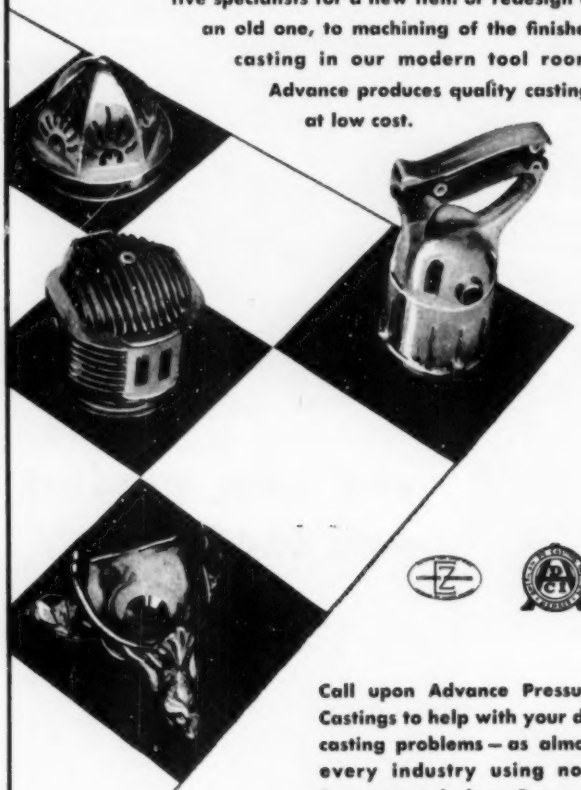

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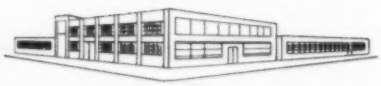

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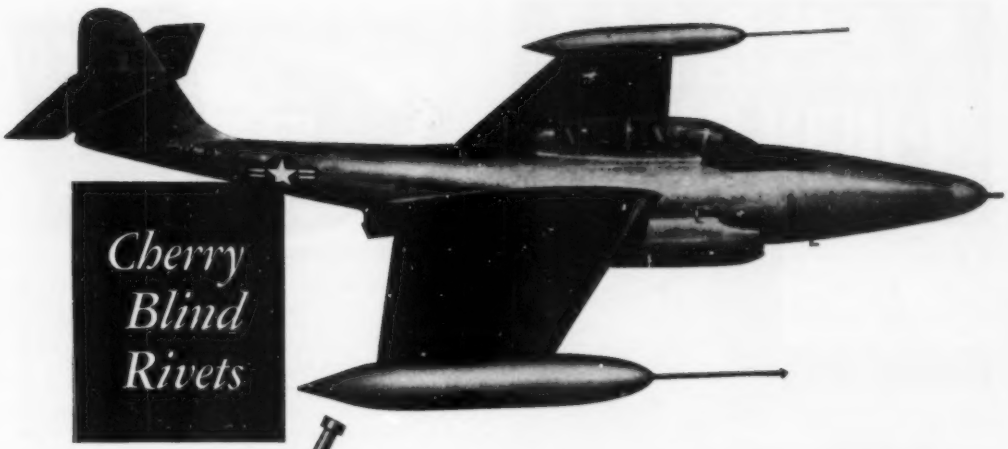


save time... speed production on the Northrop F-89

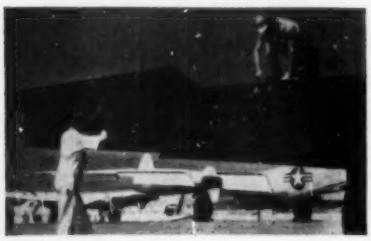
Here's the U.S. Air Force's new Scorpion F-89 all-weather fighter now rolling off the production line at Northrop Aircraft, Inc., Hawthorne, California. Combining range, speed and punch with "X-ray eyes," the Scorpion is the jet-propelled successor to the famous World War II Black Widow.

Note the jaw-like control surfaces at the outer end of the wing's trailing edge. These are Northrop's latest development—"Decelerons." Combining the functions of ailerons, fighter brakes and landing flaps, Decelerons pack extra maneuverability and weight-lifting ability into this razor-winged, twin-jet fighter.

Note also that Northrop uses Cherry Rivets in the fabrication of these Decelerons. Like many other aircraft manufacturers, Northrop Aircraft, Inc. has found Cherry Rivets make their hard jobs easy.

Cherry Rivets are installed by one man from one side of the work. They eliminate the two-man crew used to buck solid rivets. It's a pulling action that does the work—no twisting, no exploding, no hammering.

Cherry Rivets are ideal for double-surface structures, box sections, tubes, ducts and other "hard-to-get-at" spots. They speed assembly . . . cut man hours . . . lower unit costs. If you're not familiar with Cherry Rivets and their time-saving potentials, take a moment now to write for full information.



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*Ball assembly also available without housing—ideal for integral inclusion on original equipment applications—easily adapted for grease type lubrication. If you have an unusual application problem send it to Randall. Our engineering department will be happy to assist you.

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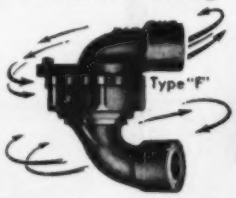

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through moving pipe lines

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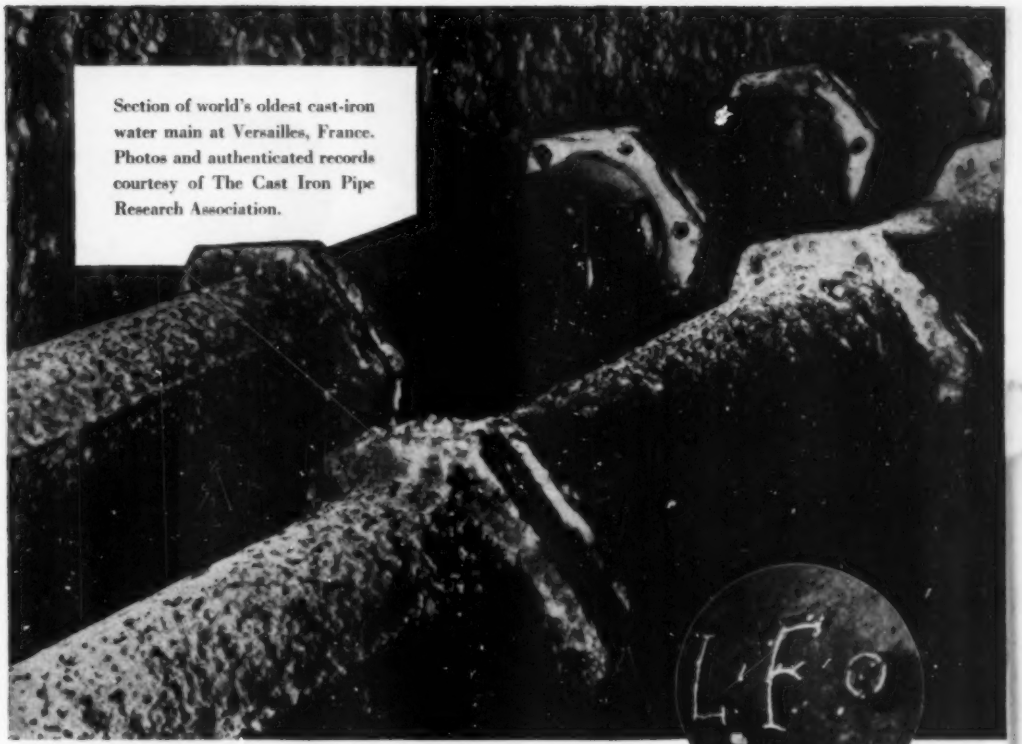

Section of world's oldest cast-iron water main at Versailles, France. Photos and authenticated records courtesy of The Cast Iron Pipe Research Association.

Section of pipe in which are cast the initials of Louis of France, in whose 17th century reign the mains were installed.

INSTALLED IN 1664

...and Still in Service

Above you see a section of the oldest cast-iron water mains in the world—supplying the town and parks of Versailles, France.

Installed in 1664 by order of Louis XIV of France, they are still functioning after 286 years of service.

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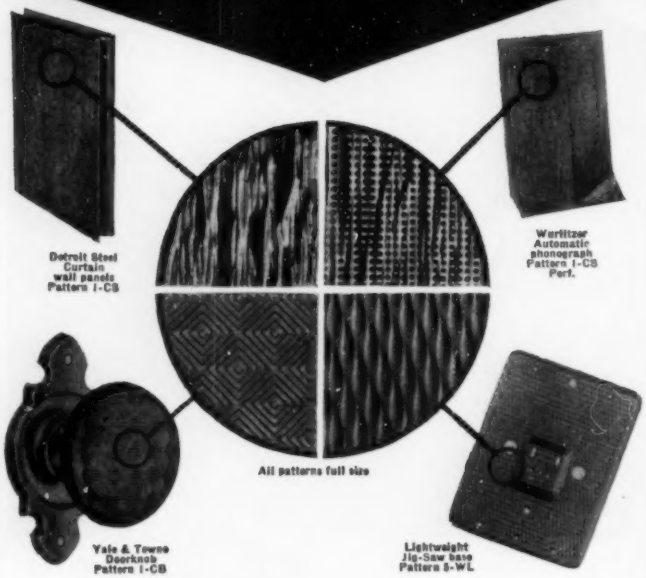
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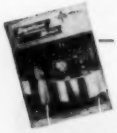

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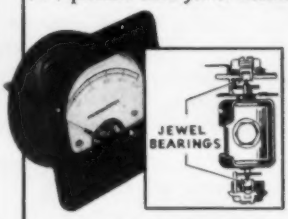

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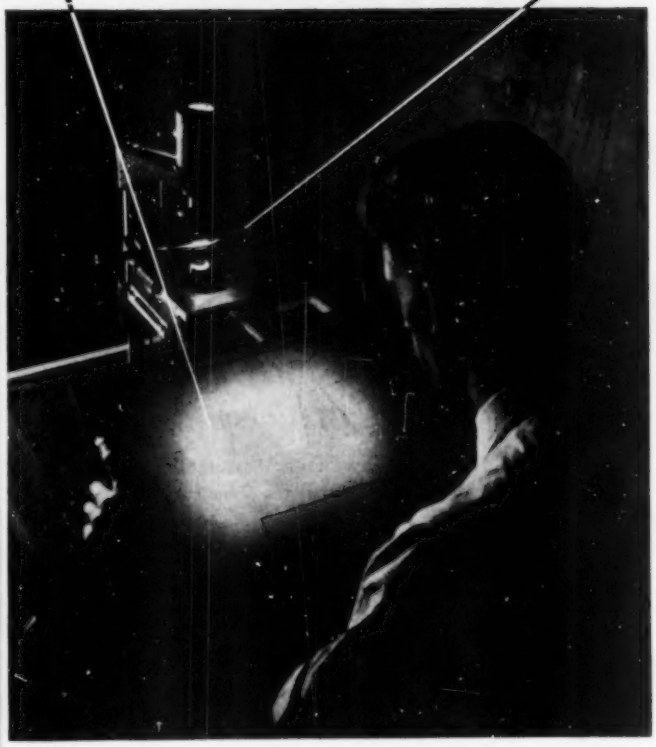

Checking tooth form.

• This is one of the many tests which Perkins Gears must pass prior to their admission into our shipping department.

• The variety and accuracy of the equipment used in our inspection department, plus the severity of the tests themselves, keep the number of gears returned to us by customers as "rejects" correspondingly low. The rigor of our inspection methods is, to us at Perkins, just a matter of plain ordinary horse-sense — a commodity which is plentiful in New England. We thus reject it as a virtue to be proclaimed from the housetops, and offer it to our customers as a normal part of our services: *The production of precision, custom-made gears.*

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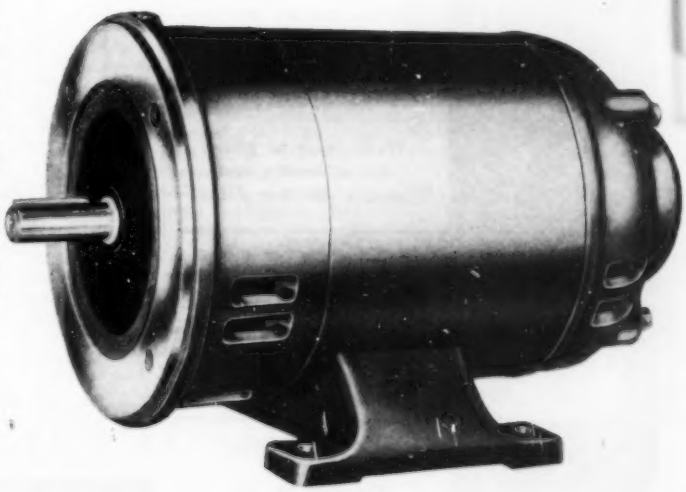
Other capacitor-start Hoover Motors from ¼ through 3 HP. Polyphase motors from ¼ through 5 HP. Write for details.



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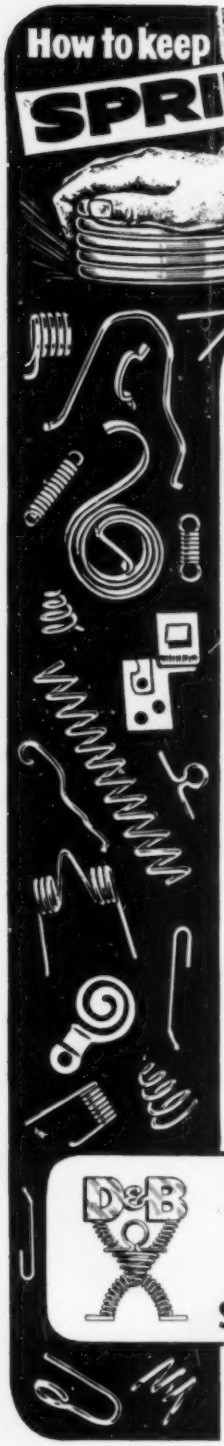

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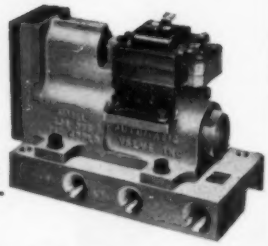

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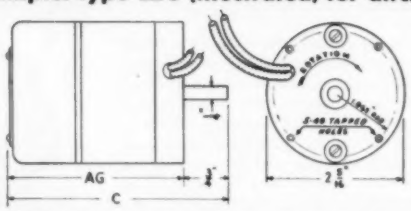
Special Design Motors

Example: type LD3 (illustrated) for aircraft



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12-32 volts D.C. — With or without electrical Governor — Ball Bearings — Details on Request.

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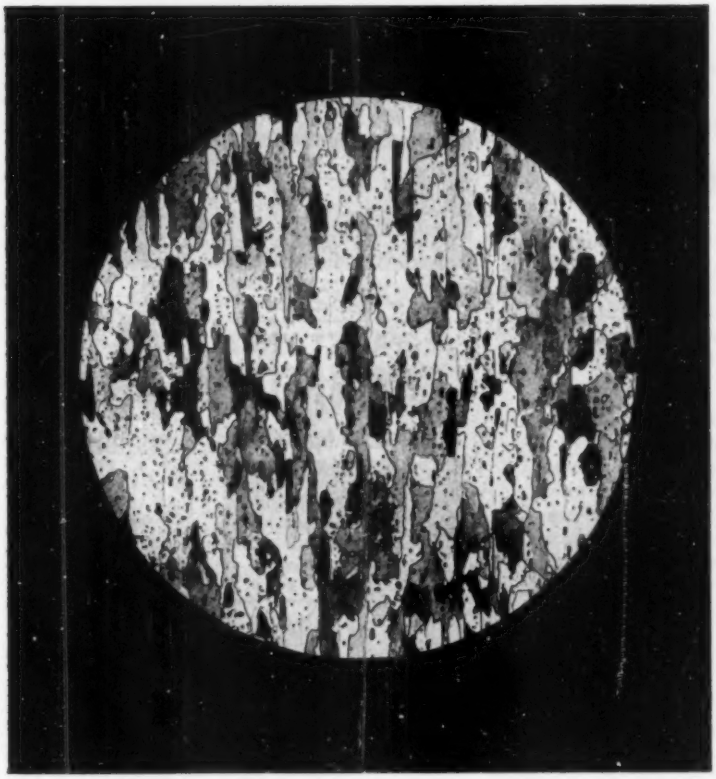


Picture puzzle – a key to better aluminum!

THIS is a sample of a Kaiser Aluminum alloy magnified 120 times!

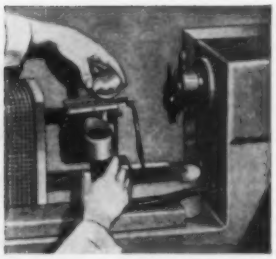
By studying it, Kaiser Aluminum metallographers are able to answer a wide variety of questions about the metal.

For example, they can tell whether the metallurgical structure is most suitable for the use to which the alloy will be put. Or if the alloy presents any production problems in the customer's plant, they can analyze the internal physical structure and recommend proper fabricating practices.

Today, such research as this is paying off in new aluminum alloys, improved fabricating techniques, more efficient utilization of the metal now so vitally needed in the nation's preparedness program.

To help meet the critical demand for aluminum, Kaiser Aluminum has begun a vast expansion program which will greatly increase production of primary aluminum. As soon as possible, this aluminum will be shared by manufacturers of civilian products.

Call us on any fabricating problem. Kaiser Aluminum & Chemical Sales, Inc., Oakland, Calif. 63 sales offices and warehouse distributors in principal cities.



AUTOMATIC QUANTOMETER analyzes samples of Kaiser Aluminum while the metal still is molten in the furnaces. When it's poured, the aluminum measures up to exacting specifications.

LABORATORY TESTS of customer fabrication methods are often made to determine if a different alloy or technique would do a better job and save money.

CHEMICAL LABORATORY makes frequent analyses to help maintain top quality that Kaiser Aluminum customers always get.

PHYSICAL TESTING of tensile and yield strength, fatigue properties, grain size, hardness, etc., is another detailed check to assure Kaiser Aluminum's high standards are met.

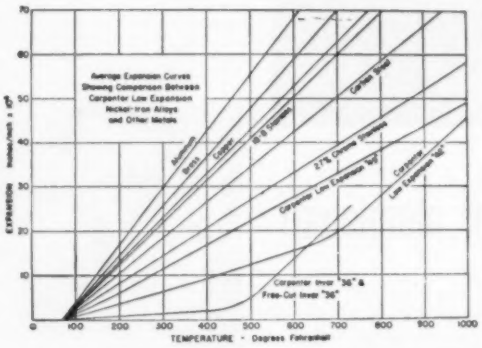
Kaiser Aluminum

Setting the pace . . . through quality and service

An alloy with practically no thermal expansion up to 400°F

Note in the graph how the low thermal expansion rate of Carpenter Invar "36" compares with other metals. The free-machining alloy, Carpenter Free-Cut Invar "36", has the same low expansion characteristics and simplifies production of machined parts.

Where the operation of precision instruments or machines is affected by temperature variations, the low expansion of this alloy helps to insure constant accuracy. Another important use is in automatic on-and-off controls, such as thermostats. These controls are operated by the difference between invar's low expansion rate and that of a high expansion metal.



For detailed engineering data on the Carpenter Invar "36" alloys, write for a copy of the Carpenter Low Expansion Alloy book. It contains 23 pages of data on expansion and mechanical properties, physical constants, etc.

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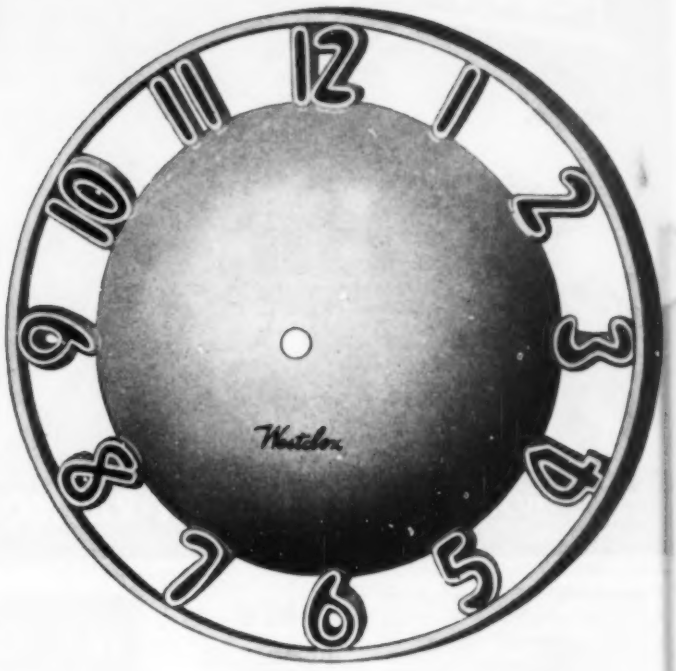

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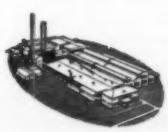

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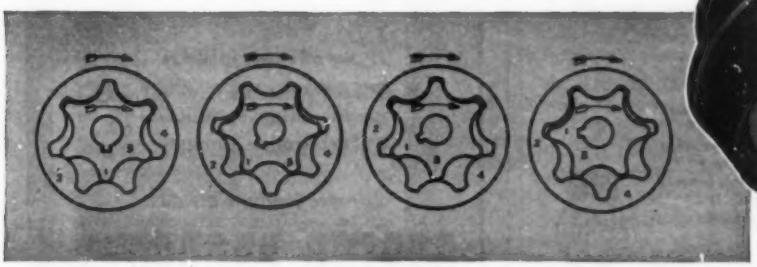

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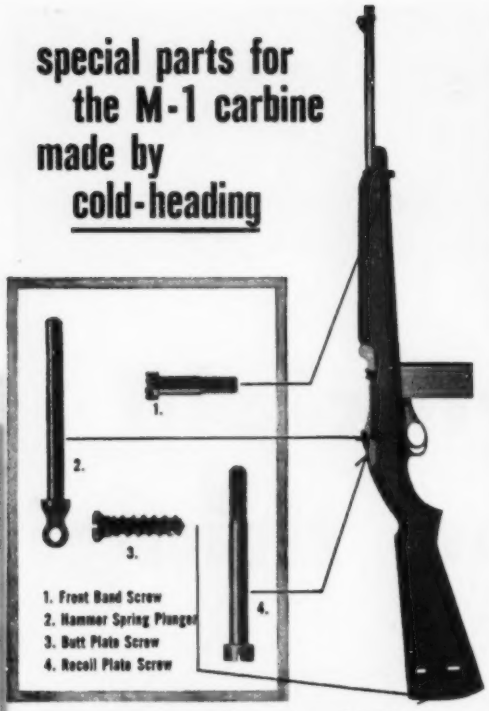

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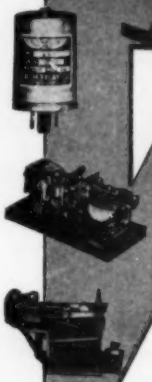

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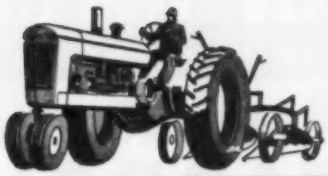

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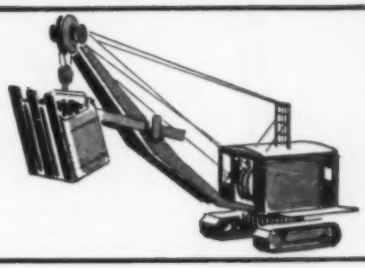

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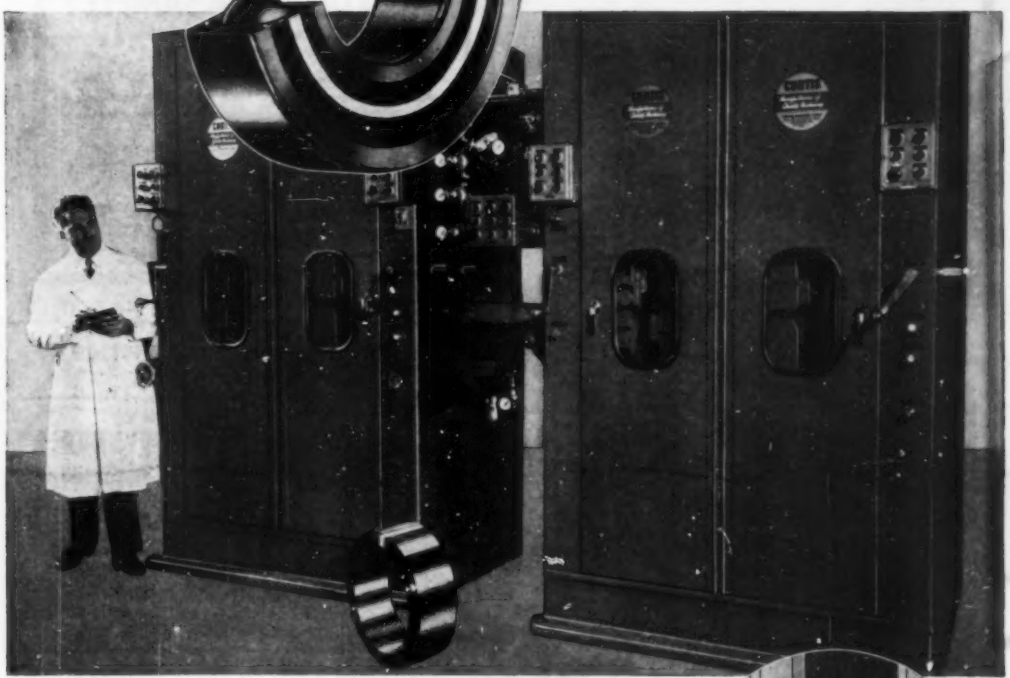
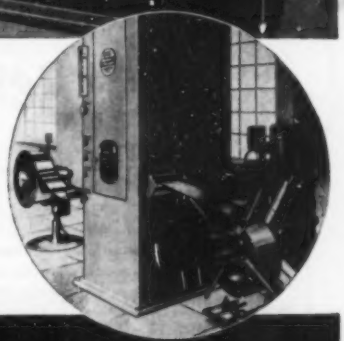


CURTIS STRAIGHT-O-MATIC in a leading New England Steel Mill



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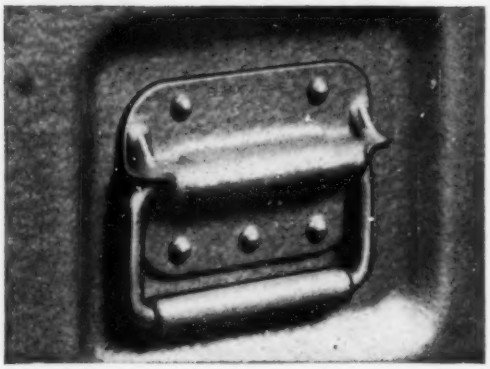

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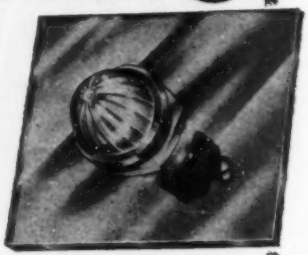

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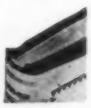

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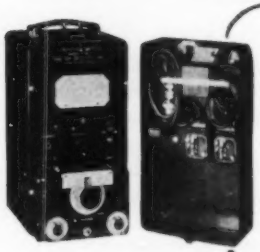

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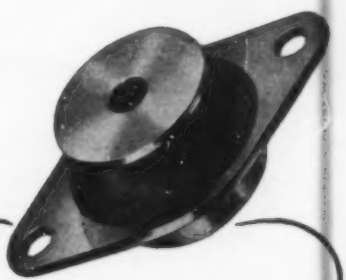
The improved MB Vibration Meter interprets the nature of vibration picked up. It gives you direct readings on velocity, acceleration or displacement of vibration by simple switch selection. A rugged, accurate and portable unit, it is being used effectively both for quality-control work and research.



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Many engineers now know that Isomode* Mounts not only simplify designing, but provide superior isolation as well. Possessing equal spring rate in all directions, these units absorb vibration in all planes, and may be installed at any angle. They have high load capacity in small size. Also unusual stability for their softness, and self snubbing feature for overloads.

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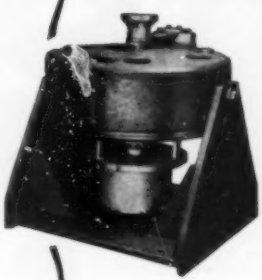

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Planting Seed

Anyone who plants seed haphazardly can expect haphazard results. Planting seed *properly* takes a lot of care.

It's the same way with our business. We get a lot of small orders, and welcome them. But, like most businessmen, we want our small accounts to grow into larger ones. We've found that the only way to get *big* orders, is to get *small* orders and do them well. That's been a continuing policy with us. We've made gears from thousands of patterns, and we have the engineering staff to provide any special gear in any size, for any purpose. We like to feel that our garden of customers grew from well-cultivated seed. THE EARLE GEAR & MACHINE CO., 4707 Stenton Ave., Philadelphia 44, Pa.

It's good business to do business with EARLE

EARLE GEARS

PRECISION DIE MADE — LOWEST POSSIBLE COST
DAYTON ROGERS MFG. CO.
Minneapolis 7, Minnesota

1919 1951
CURTIS *Exclusively a manufacturer of* **UNIVERSAL JOINTS**

FOR A QUARTER OF A CENTURY

Curtis Standards exceed the Class I specifications set for the Army, Navy and Air Force

- Ball type — for light duty
- Standard — for heavy duty
- Lo-Friction — for special duty
- Single or double
- Solid or bored
- Complete range of 14 sizes stocked ⅜" thru 4" O.D.
- Special inquiry for other than stock sizes and for special applications invited
- Write for Free Price List and Engineering Data Catalog

CURTIS UNIVERSAL JOINT CO., INC.
11 BIRNIE AVENUE, SPRINGFIELD 7, MASS.

NEW PRINCIPLE of GUIDEROL

...solves your TOUGHER bearing problems

The McGill GUIDEROL Roller Bearing is especially designed to take advantage of the greater capacity of cageless roller bearings — without the danger of roller skewing. This new principle of construction features guided rollers that overcome skewing tendencies and eliminate the need for space wasting cages and internal looseness. Load capacity in cylindrical roller bearings is not only increased with Guiderol Bearings but this advantage is effectively applied to faster and more precision applications—not before possible with full type cylindrical roller bearings. You will profit by investigating these and many other advantages of Guiderol Roller Bearings.

GUIDED ROLLERS PREVENT SKEWING — BINDING

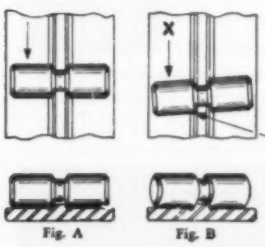

Fig. A Fig. B

A guide rail on the inside diameter of the outer race maintains roller alignment. Normally no correction is required. Should misalignment cause tendency to skew, the guide rail touches grooved rollers back into position by momentary contact at Y. X indicates direction of roller rotation.

Bulletin GR-50 lists proposed standard sizes in CT Series (interchangeable with cylindrical type dimensions) for PT Series (interchangeable with ordinary needle type dimensions). Write McGill Manufacturing Co., Inc., 201 No. Lafayette St., Valparaiso, Indiana for your copy.

McGILL®
precision bearings

Tell Us Your Production Problems . . . We'll Help You Solve Them

"LOGAN" AIR AND HYDRAULIC EQUIPMENT
• • • SINCE 1916 • • •

Logan plant floor area, over 100,000 sq. ft.

Logan production equipment, over 150 modern productive machine tools.

Logan's approximately 500 employees have an average of 10 years with the company . . . a continuous service total of 5,000 man-years.

Logan manufactures 6,975 standard cataloged items.

Logan serves more than 6,000 customers annually; 99.6% satisfied.

Let Logan engineers help you design your Air and Hydraulic Circuits.

Logan SAVES TIME EFFORT MOTION
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- AIR CONTROL VALVES — CATALOG 100-4
- AIR CHUCKS — CATALOG 70-1
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- AIR and HYDRAULIC PRESSES — CATALOG 51
- HYDRAULIC CONTROL VALVES — CATALOG 200-4
- HYDRAULIC CYLINDERS — CATALOG 200-2; ALSO 80-2
- HYDRAULIC POWER UNITS — CATALOG 200-1
- SURE-FLOW COOLANT PUMPS — CATALOG 62
- COLLET GRIP TUBE FITTINGS — CATALOG 44

LOGANSPORT MACHINE CO., INC. 812 Center Ave. Logansport, Ind.

FLUID POWER SPECIALISTS SINCE 1916

ONE WASHER INSTEAD OF TWO WITH WEATHERSEAL!

The Weatherseal Washer combines a metal and a compressive, sealing washer, hydraulically bonded and "cured" together to provide just one piece to handle. The compressive material is composition rubber or neoprene, and it does a real job of sealing as this actual cutaway photo shows:

Pat. applied for

Note that the neoprene is extruded under compression to completely seal the outer edge of the metal washer as well as the fastener shank, through the metal sheets to the nut.

APPLICATIONS: Sheet metal roofing and siding • Auto body and chassis assembly • Sheet metal ductwork • Porcelain-to-metal assemblies.

TOPSEALS are fasteners you specify or supply—nail, bolt, sheet metal screw, etc.—assembled in our factory with Weatherseal Washers, ready for use. Reduce your inventory items with TOPSEAL! Write for sample and prices, stating your fastening or sealing problem. Proven production performance and large stocks maintained for quick shipment assures you of meeting your own production schedules.

FABRICATED PRODUCTS COMPANY
WEST NEWTON, PA.

AUTOMATIC
MERCURY CLUTCH

Performance-tested for Years on Thousands of Installations

for ELECTRIC MOTORS
- SAVES starting current
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- PREVENTS motor damage

for GASOLINE ENGINES
- ELIMINATES stalling
- INSURES load-free starting
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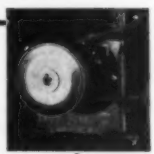


A Mercury Clutch not only improves the performance of appliances and equipment powered by electric motors and gasoline engines but also adds to their saleability.

For full information write today for Bulletin PR-3.

Mercury Clutch Division
AUTOMATIC STEEL PRODUCTS, INC.
CANTON 6, OHIO

JOHNSON BRONZE
SLEEVE BEARING DATA

Bearing TYPES

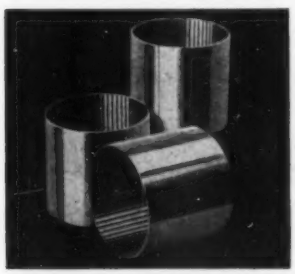
JOHNSON BRONZE
SLEEVE BEARING DATA

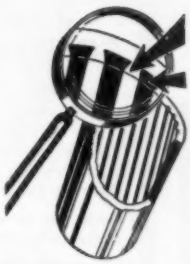
Graphited Bronze Bearings

GRAPHITED SLEEVE TYPE BEARINGS were developed primarily for applications where lubrication is difficult, likely to be neglected and where the speed of the shaft is too slow to sustain an oil film. They are also used in some applications where ordinary lubricants might damage goods or food products in process and where temperatures are too high for oil or grease.

There are three fundamental types available: cast bronze with serrated grooves, cast bronze with graphite plugs and bronze sheet metal with serrated, rectangular or diamond shape indentions.

In the cast bronze serrated type, minute, dovetailed grooves are cut into the bearing surface at a 7 degree lead. Graphite is then compressed into these serrations and remains permanently in place. This type provides from 40 to 45% graphite contact with the shaft which increases slightly with wear.





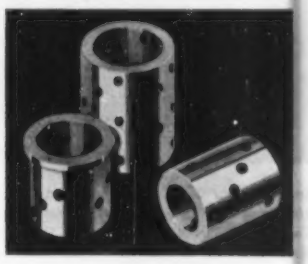
· · · Serrated type graphite bearing. Note the 7° lead and the dovetail shape of the serrations.

Plug type graphited bearings are produced by drilling holes of a suitable size in a cast bronze bearing on a staggered pattern through the wall. Stick graphite is then forced into these holes and remains permanently in place.

In some applications, ordinary oil grooves or combinations of oil grooves can serve as recesses to hold the graphite. It is also possible to compress graphite into grooving on the flange of cast bronze bearings when the application requires it.

The first step in producing bronze sheet metal graphited bearings is to cut serrations longitudinally into coiled strips of sheet bronze. The graphite is then forced into these serrations by a high pressure, patented process and baked under a carefully controlled temperature. The strip material is then blanked and formed into cylindrical shapes. In producing the cylindrical shape the serrations automatically become dovetailed which holds the graphite permanently in place.

Cast graphited bearings can be reamed in place, a maximum of 0.005 stock being removed. Sheet metal bearings *must* be burnished in place. The graphite used in Johnson bearings is not soluble in water, oil or gasoline. An occasional application of oil or grease where permissible will greatly increase the life of the bearing and lower the coefficient of friction. Cast graphited bearings are recommended for applications having slow speeds and minimum loads. For intermittent service or oscillating motion we recommend sheet metal with graphite. Quantity is a factor also and in large production runs of any given size, sheet metal is surprisingly low in cost.



Limiting Factors For Successful Performance

1-Speed—Load Factors:

(a) For constant running shafts—PV = 18,000# in (min.) sq. in. proj. area.

(b) For constant running shafts (with supplementary lubrication) PV = 120,000# in (min.) sq. in.

(c) For Oscillating shafts—PV = 60,000# in (min.) sq. in.

(d) Intermittent service—PV = 120,000# to 250,000# in (min.) sq. in. (use safety factor)

2-Bearing Pressures:

(a) All graphite jobs (without additional lubrication) 40 to 50# sq. in. (for speeds of 30 ft. per min.)

(b) With supplementary lubrication 350# sq. in.

3-Temperatures:

(a) Standard graphited bushings—Satisfactory up to 250° F. 275° F. (Using conventional leaded bronzes and serrated type.)

(b) For temperatures up to 400° F. Conventional leaded bronzes with graphite plugs.

(c) For temperatures—Up to 1000° F. Special lead bronze alloys with graphite plugs. At higher loads, oil should be used in conjunction with the graphite plugs for higher efficiency.

4-Running Clearances:

(a) Constant running shafts—50% higher than standard.

(b) Oscillating shaft—Standard allowance can be used.

5-Wall Thickness:

Minimum thick. ⅛" for O.D. up to 1".

Minimum thick. Serrated type ⅜" for O.D. over 1".

Max. wall thick.—Optional to designer. For plug type graphite—wall to be same as diameter of graphite plug—¾ min.

6- Graphited bushings should be recommended for speeds less than 30 ft. per min. for at such low speeds it is impossible to develop film pressure necessary to prevent metallic contact.

7-Stock Allowance for finishing

(a) It is necessary to finish bushing in assembly. Reaming stock allowance of not more than 0.005 should be allowed for cast bronze graphited.

(b) At least 0.004 stock for burnishing sheet metal graphited.

Ledaloyl Bearings

While graphited bearings are sometimes referred to as "Self-Lubricating" Johnson Bronze produces another type by powder metallurgy known as *Ledaloyl*. This bearing is low in cost, high in efficiency and holds up to 35% oil by volume. It is particularly economical when produced as a self-aligning, flanged or other odd shaped part as there is no machining required. Write for complete details.

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS
508 S. MILL ST. • NEW CASTLE, PENNA.

Imagine your dog's delight on seeing a solid column of biscuits 160′ long and 42″ wide! That's the carrying surface of this Cambridge Woven Wire Conveyor Belt in a recirculating oven at Kendall Foods Company, Bell Gardens, California.

Balanced Weave, specified for this installation, is low in cost, eliminates creeping of the belt on the drive pulley, and provides high tensile strength. Open mesh of the belt allows free circulation of heat within the oven . . . crumbs and broken bits of biscuit fall through the belt, cannot foul up automatic packaging equipment at the end of the oven.

Whether you're baking biscuits, processing meat or canning vegetables, there's a Cambridge Woven Wire Conveyor Belt to help mechanize your production. Stainless steel to meet sanitary codes is a standard material of construction for our food plant customers. Call in your Cambridge field engineer today, let him explain the superior construction features of **Cambridge Woven Wire Conveyor Belts . . .**

The Cambridge Wire Cloth Co.
Dept. P • Cambridge 5, Md.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

OFFICES IN PRINCIPAL INDUSTRIAL CITIES
See "Belting - Mechanical" in your Classified Telephone Directory.

WRITE FOR FREE MANUAL illustrating and describing conveyor belt installations for food, metalworking, chemical, ceramic and other processes.

DOES YOUR PROBLEM INVOLVE . . . . ? . . . if so CONSULT US

- Corrosion Resistance
- Strength in Tension and Compression
- Hardness & Toughness
- Pressure-Tightness
- Resistance to Erosion
- Resistance to Frictional Wear
- Fatigue Resistance

Most certainly there is one of "our own alloys," or one of the many non-ferrous alloys we make that will meet your exact requirements—At any rate, our long and varied experience as Metallurgical Engineers and Founders is at your service for any problem or product you may have.

Please send me a copy of your latest "Reference Book of Bronze Casting Alloys."

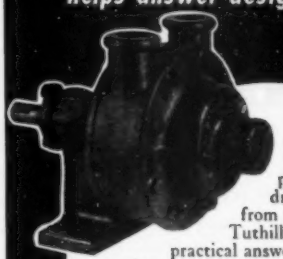
AMERICAN MANGANESE BRONZE COMPANY

4705 Rhawn St., Holmesburg, Philadelphia 36, Pa.
PITTSBURGH, PA.

Established 1909

This TUTHILL

Automatic Reversing Pump helps answer design problems



If your problem involves driving the pump from a reversing shaft, Tuthill Model R is a practical answer. This automatic reversing pump delivers from the same port regardless of direction of shaft rotation. Its flexibility of performance makes it ideal for lubrication and coolant service, particularly wherever the ultimate direction of shaft rotation is not known. Capacities from 1 to 200 g.p.m. and pressures up to 100 p.s.i.

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TUTHILL PUMP COMPANY
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Any Speed YOU NEED

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. . . because it is available in single, double or triple reductions, offering a range of speeds: 780 through 7.5 r.p.m. Motor rating from 1 h.p. through 60 h.p.—A-c or D-c. The motors and gear units are each self-contained and readily separated . . . gears in multi-reduction units may be inspected, without uncoupling from driven machine.

These small, compact, self-contained units simplify the direct application of electric drive to individual machines.

GearMotoR conforms to the recommended standards of the American Gear Manufacturers Association and the National Electrical Manufacturers Association.

Send for 42-page illustrated catalog, containing full information and data necessary for ordering, and please use your Business Letterhead when requesting same.

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Industrial Gears and Speed Reducers
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TV and RADIO MANUFACTURERS ARE MAKING

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SELENIUM RECTIFIERS

YOU'VE got to hand it to Federal Selenium Rectifiers for the *vital* job they are doing for America's leading television and radio receiver manufacturers!

Power transformers, rectifier tubes and filter chokes are being *eliminated* . . . heavy percentages of copper and steel are being conserved. . . receivers are more compact and efficient . . . space and weight are saved in production, shipping and warehousing . . . assembly time is saved . . . costs are cut up and down the line and production facilities are kept on the move.

Product-design engineers with power conversion problems that can be solved with Selenium Rectifiers are urged to get in touch with Federal – the *originator* of the Miniature Selenium Rectifier. Federal–and only Federal–has the most complete information available today on this outstandingly versatile unit. Send your requirements to Dept. F-442 for a quick reply!

Federal "PREFERRED TYPES" Handle 90% of Today's TV-Radio Replacements:

FTR 1004 Used for Replacing 50-100 MA, 130 Volts
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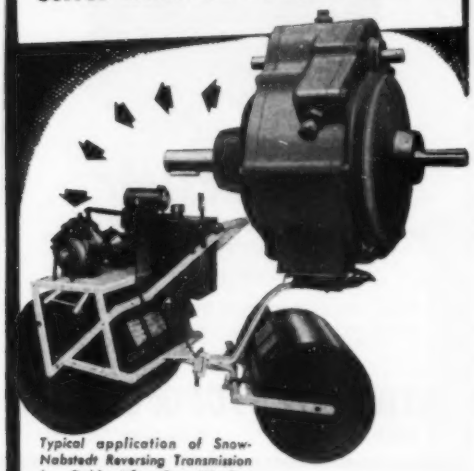
Amazing NEW REVERSING TRANSMISSION

Solves Numerous Design Problems



Typical application of Snow-Nabstedt Reversing Transmission by Gabb Mfg. Co., Windsor Locks, Conn. on its "Motoroller".

- SO UNIQUE — One unit combines forward, neutral, reverse and reduction . . . no separate clutch required! Has coaxial input-output shafts.
- AMAZING PERFORMANCE — Reverses occasionally, or frequently, under full load, without hesitation! Transmits 2 to 12 H.P. with 3.75: 1 reduction in both directions.
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- SAVES MONEY — Eliminates separate gear box, clutch, countershaft and mounting brackets in many applications. *SAVES assembly time, servicing problems, and improves product appearance.*
- SAVES SPACE — The most compact transmission available . . . only 9-1/16" x 8" x 9-1/2".
- QUALITY-ENGINEERED — Designed by makers of Joe's Famous Gears, world-renown for 46 years. Have our capable engineers produce transmissions to serve your defense equipment needs!

WRITE TO-DAY for descriptive bulletin or specify your needs, stating application, input and output speeds desired, H.P., power source, equipment to be driven.

THE SNOW NABSTEDT GEAR CORP. REVERSE & REDUCTION S-N GEARS HAMDEN, CONN. U.S.A.

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SNOW-NABSTEDT GEAR CORP.
P. O. BOX 1753, NEW HAVEN, CONNECTICUT, U.S.A.

An Arwood casting saves time! money!

ARWOOD's engineering skill and production efficiency make it possible to produce the cam illustrated by the precision investment casting method.

This is a stainless steel release cam for food machinery. Originally it was to have been machined from a 2" solid cube of steel. But made as an investment casting, all machining has been eliminated except the drilling of one small blind hole and the turning of the shank to a tolerance of ± .0005. Notice the details of the slot and cam groove which are held to tolerances of .004.

While the saving of valuable machining time is important, it is interesting, too, that an actual saving of 58% was made over the cost of making the cam by other methods.

Perhaps you have a production problem that Arwood can help you solve. Our engineers, with years of experience in many industries, often are able to make valuable suggestions that result in important savings in manufacturing.

For more complete information about the accuracy, the lower costs and the versatility of precision casting, write for our booklet, "A Critical Survey of Investment Castings."

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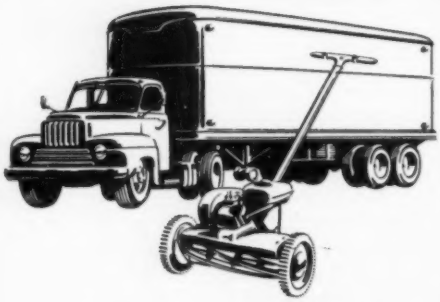
68 WASHINGTON STREET • BROOKLYN 1, N. Y.
Plants: Brooklyn, N. Y., Groton, Conn., Tilton, N. H.

Zenith

HAS A WIDE RANGE OF CARBURETOR TYPES



TO FIT A WIDE RANGE OF APPLICATIONS!

Are you looking for an unusual size or type of carburetor? Perhaps Zenith* has the answer to your problem. For more than 35 years Zenith has been designing and building carburetors for every type of engine—ranging from single cylinder lightweights to the most rugged and powerful of gasoline engines. The chances are you can use a unit Zenith is now making and avoid the cost of a specially designed carburetor.

On the other hand, if your carburetor requirements are highly specialized, Zenith's engineering experience will prove invaluable in solving questions of placement, efficiency and economy of operation. Just remember, whatever your carburetor problem, it will pay you to look to Zenith for the answer.

*REG. U. S. PAT. OFF.

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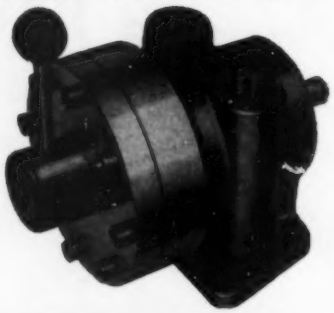
The *Controlled Flow*



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PROVIDES COMPLETE CONTROL OF
VOLUME • • • DIRECTION • • • PRESSURE
AT THE PUMP without Valves

These are only some of the features that the HYDROPUMP offers. For complete information, write for Bulletin 100-P.

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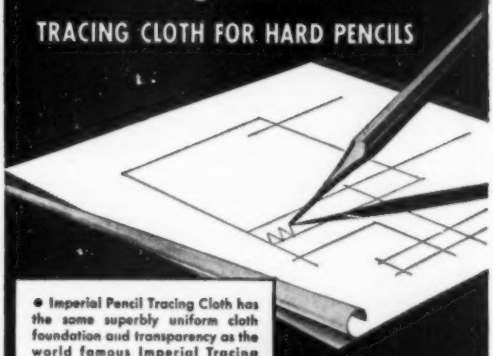

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MERCOID NON-CORROSIVE SWITCHES ELIMINATE ALL CONTACT TROUBLE

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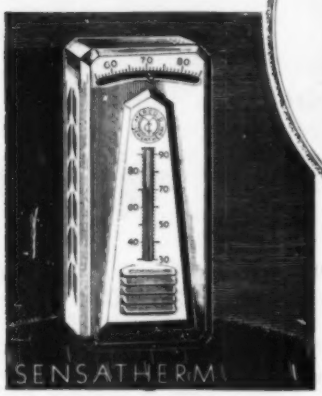
The Unexcelled Thermostat



If you have a control problem involving the automatic control of pressure, temperature, liquid level, mechanical operations, etc., it will pay you to consult Mercoid's engineering staff—always at your service.

Complete catalog sent upon request

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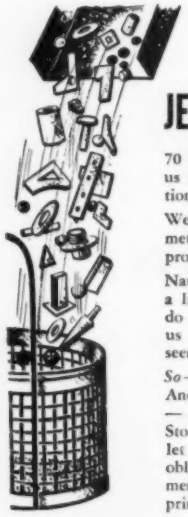

WHEN YOU PUT A LOT OF LITTLE ONES INTO A BIG ONE — MAKE SURE IT'S A

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70 years making Wire Mesh have taught us a lot about this material, its fabrication, and uses.

We make Dipping Baskets of any ductile metal, and in any size and shape your products and process require . . .

Naturally we believe we make them just a little bit better than the other fellows do — and a lot of people who turn to us regularly for their Dipping Baskets seem to agree with us.

So—for Degreasing—Pickling—Plating Anodizing — Washing — Heat Treating — or for just plain Bulk Handling or Storage of small parts in large quantities, let JELLIFF give you a no-cost no-obligation estimate for your next requirement of Dipping Baskets. Send a blueprint or specifications to Department 24

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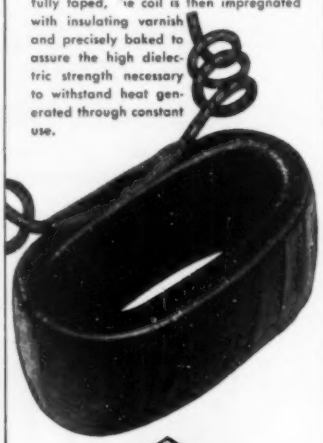
. . . this wealth of design information on 35 different classifications of product components and fabrication methods . . . from the June issue of PRODUCT ENGINEERING . . . is now available in reprint form. You can obtain copies for permanent reference at 75 cents each from our READER SERVICE DEPARTMENT.

PRODUCT ENGINEERING
McGRAW-HILL BUILDING, NEW YORK 18, N. Y.

The Taft-Peirce SUPERPOWER magnetic chuck is demonstrably the most powerful magnetic chuck made, possessing holding power even greater than is demanded by the latest machine tools. Shown below is a coil which helps give this famous chuck its SUPERPOWER. Accurately form wound from cotton-covered enamel wire and carefully taped, the coil is then impregnated with insulating varnish and precisely baked to assure the high dielectric strength necessary to withstand heat generated through constant use.

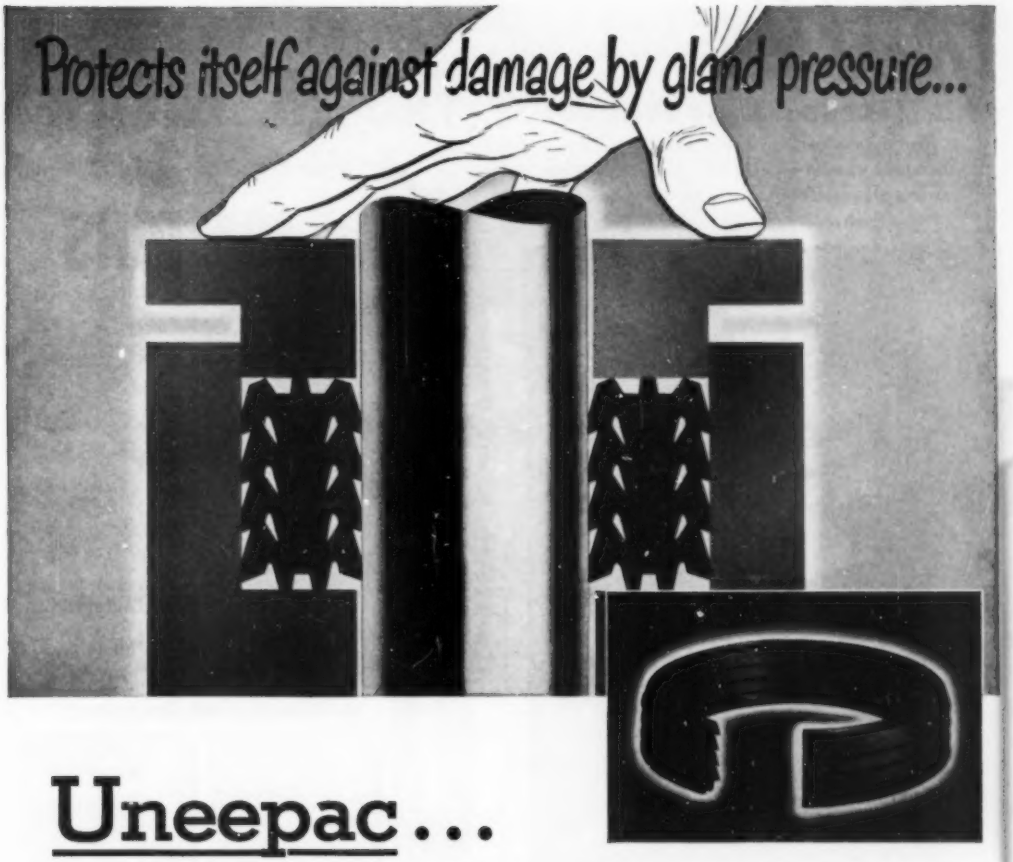


Coto SINCE 1917

Builds Them!

When you need electrical coils, why not take advantage of 34 years of experience, engineering competence, and modern production facilities. Coto coils are built for you, to your specifications.

COTO-COIL CO. INC.
COIL SPECIALISTS SINCE 1917
65 PAVILION AVE
PROVIDENCE 5, R.I.



Uneepac . . .

the new Johns-Manville automatic ring packing

HERE AT LAST is an automatic ring packing that's designed to eliminate one of the most common causes of packing failures!

A glance at the cross section above will show you why. Note the projecting portions of the center section of each Uneepac ring. These projecting "legs" provide an effective safeguard against damage by excessive gland pressure. Header and follower rings are therefore seldom required.

Another important advantage is also provided by this unique design. Each Uneepac ring centers itself on the preceding ring so that the entire set is aligned vertically and nested perfectly. This feature practically insures trouble-free installation.

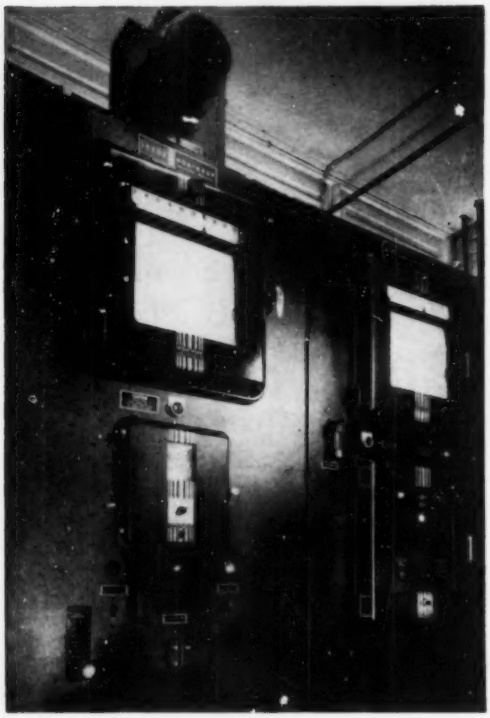
If you are looking for an automatic ring packing that seals effectively in a minimum of space . . . operates with a minimum of friction . . . and is instantly responsive to fluid pressure changes . . . you will want all the facts about Uneepac. Bulletin PK-58A is free for the asking. Just address Johns-Manville, Box 290, New York 16, New York.

Johns-Manville PACKINGS & GASKETS

Thank You

LEEDS & NORTHRUP!

Your development of the Microcarb Control for precision heat-treating is a big help to the gear industry. We are proud to be among the first to obtain such revolutionary precision control.



Now, for the first time . . .

. . . we are able to control case carbon content on carburized parts.

. . . we can produce carburized surfaces with absolute uniform control and obtain absolute maximum hardness and maximum ductility.

No more . . .

. . . retained austenite on wearing surfaces of high nickel steels.

. . . carbide networks in the hypereutectoid zone.

Thank you, **LEEDS & NORTHRUP**

Indiana GEARS

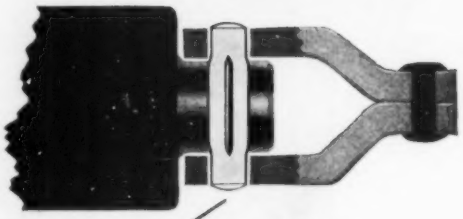
GEARS • CAMS • INTRICATE AND PRECISE MACHINE PARTS

INDIANA GEAR WORKS • INDIANAPOLIS 7, IND.

FASTER...EASIER

Assembly with

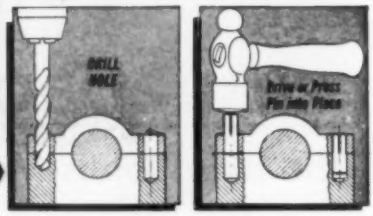
DRIV-LOK PINS



TYPE "E" PIN

- ★ Simple Installation
- ★ Low Cost
- ★ Wide Selection of Materials
- ★ Versatile...Types for Most Applications
- ★ Vibration and Shock-proof

2 EASY STEPS

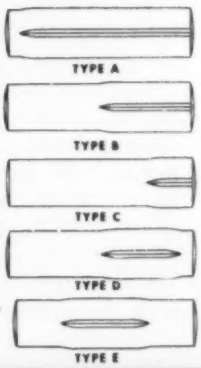


DRIV-LOK Pins speed assembly because they require only a drilled hole for installation—no taper or size reaming necessary. Drill the hole—drive or press in the pin . . . the job is complete.

Type E DRIV-LOK Pins (illustration at top) find many applications as pivot pins, T-Handles in tools and valves, cotter pins, cross pins, etc.

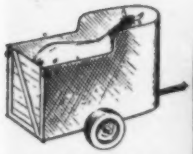
DRIV-LOK Pins are available in many types—in carbon steel, stainless, alloy and brass; diameters from 3/64" to 1/2", can be heat treated or plated to your specifications.

Write for catalog and samples, giving nature of your fastener problem.

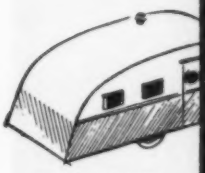


DRIV-LOK PIN COMPANY

723 Chauncey St. • Sycamore, Ill.



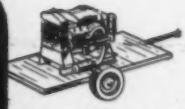
ANIMAL TRAILERS



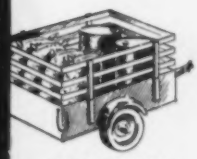
HOUSE TRAILERS

LUGGAGE TRAILERS

Price and Performance MAKE LEVEL-LOAD AXLES Ideal for All Towed Trailers *HERE'S WHY...*



MACHINERY TRAILERS



FARM TRAILERS

BOAT TRAILERS

• You can't beat an ASF-Linco Level-Load axle for performance and economy. This completely assembled towed-trailer unit gives top efficiency under any load—a dependable, easy ride at all times.

IT'S SIMPLE. The unit consists of two helical torsion springs around a forged-steel, offset-spindle axle, and two bearing brackets for trailer support.

RIDES EASY. Variable-ratio springing adjusts itself to load conditions; cushions trailer against shocks, shifting loads, and sudden starting and stopping. Deflection rate changes automatically to exactly the right capacity for proper balance of spring tension with the weight of trailer load.

LEVEL LOAD. Uneven load placement will not sway, tip, or turn a trailer that has an ASF-Linco axle. Weight of off-center load is evenly distributed to the two springs. Both sides of trailer are depressed equally. There can be no dead axle spring on one side and high spring on the other.

TRACKS WELL. Trailers equipped with Level-Load axles pull evenly against the drawbar, track exceptionally well—carry loads safely and steadily. Unique springing permits a low center of gravity, and the "level-load" feature minimizes normal trailer tendency to overturn on curves.

SIMPLY INSTALLED. Four bolts mount the Level-Load axle. Anyone who can handle a wrench can install it in a few minutes. No assembly is required; the axle comes as a complete unit. The simple design eliminates spring-leaves, shackles, snubbers, U-bolts, and other components of conventional axle springing, thus saving installation cost.

MINIMUM MAINTENANCE. Level-Load axle design assures long life with minimum attention and maintenance. Bracket bearings have renewable friction inserts.

Write for Literature

PROVED PERFORMANCE

This axle is a precision-made adaptation of the Linco axle formerly produced on the West Coast. Over 100,000 now in use. Made in standard and special sizes for a variety of wheel groups. Used singly or in tandem, with or without brakes.

AMERICAN STEEL FOUNDRIES, 410 N. MICHIGAN AVE., CHICAGO 11, ILL.

TESTED – PROVEN – ACCEPTED!

CHOOSE THE

AIR VALVE

YOU HELPED DESIGN

Best for Trigger-Quick Control of all Air Operated Equipment

FULL FLOW

COMPACT

ONE MOVING PART

TWO BASIC PIPE SIZES

MAC

MECHANICAL AIR CONTROLS

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HERE'S AN Oster GUARANTEED QUALITY SPECIALTY!

COMPACT, RUGGED, PRECISION BUILT FRACTIONAL H. P. ELECTRIC MOTORS

1/1000 H. P. to 1/4 H. P.

For 25 years, OSTER has specialized in building fractional H.P. motors to meet specific requirements. OSTER is unsurpassed in engineering, tooling, and assembly of electric motors up to 6" maximum O.D. of the following types:

Direct current—6 volts to 220 volts
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Also precision electro mechanical assemblies

All this OSTER experience and precision workmanship, plus the considerable volume of fractional H.P. electric motor production, assures you a reliable source for motors of dependable performance. For full information as to how OSTER can serve your special motor needs, write, wire or telephone

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Assemblies Stay Tight —

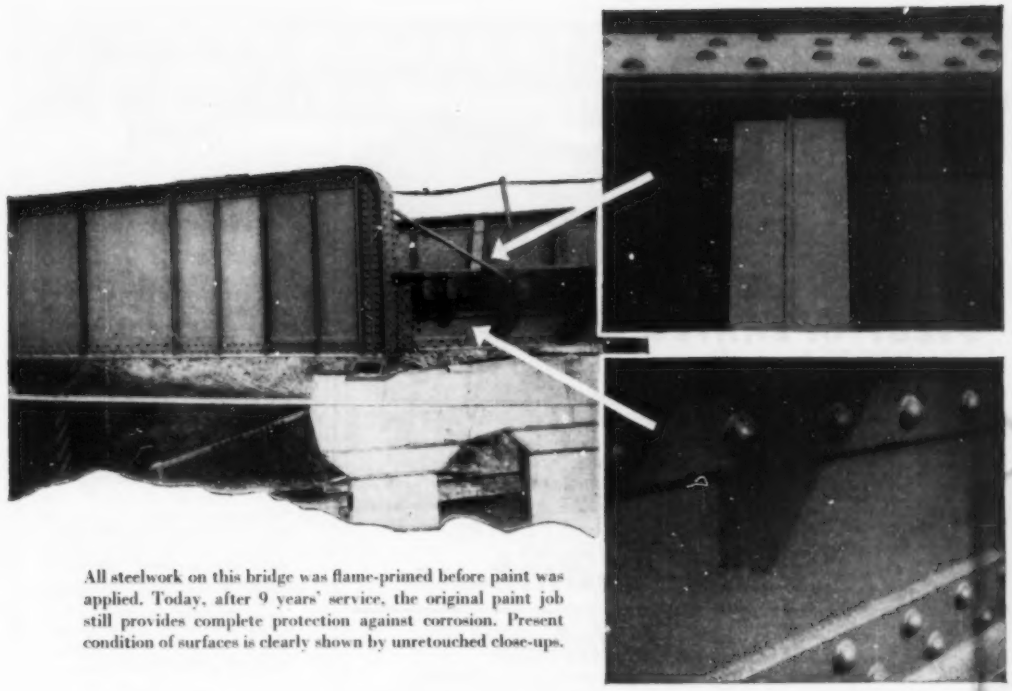
— with PALNUT Double-Locking Action

● When tightened, spring tension (A-A) is exerted upward on the screw thread and downward on the part, while spring tension (B-B) is exerted inward to grip screw thread like a chuck.

For quick, secure fastening at low cost!

THE PALNUT COMPANY
10 Cordier St.,
Irvington 11, N. J.

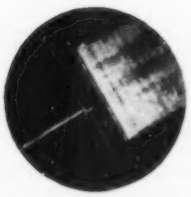
PALNUT
Trademark
SELF-LOCKING
NUTS AND FASTENERS



All steelwork on this bridge was flame-primed before paint was applied. Today, after 9 years' service, the original paint job still provides complete protection against corrosion. Present condition of surfaces is clearly shown by unretouched close-ups.

Your Steelwork . . .

How Will It Look in 1960?



Steelwork you coat with good paint today can still look like new ten years from now, *if you flame-prime all exposed surfaces first.* And what you'll save on maintenance, because of increased protection due to flame-priming, will more than pay for all the flame-priming apparatus and materials you need for the job.

Flame-priming is simple to do, requires little equipment, and costs little. A brush of oxy-acetylene flames pops off scale and drives out moisture. Paint applied to the warm, dry surface goes on quickly and smoothly, bonds tightly, and lasts longer.

Flame-priming is one of many time- and money-saving LINDE methods for making, cutting, joining, treating, and forming metals. So, whatever you do with metals, there is a good chance that LINDE know-how, show-how, and equipment can help you do it better, more quickly, or at lower cost.

To find out, without obligation, telephone or write our nearest office today. LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in Other Principal Cities. In Canada: Dominion Oxygen Company, Limited, Toronto.

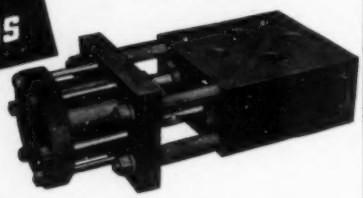
Linde Trade-Mark

Products and Processes for MAKING, CUTTING, JOINING, TREATING, AND FORMING METALS

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

¾ Inch 4-Way — 5000 p.s.i.
Piloted Hydraulic Valve



PILOT OPERATED Hydraulic Valve

For hydraulic systems to 5000 p.s.i.

● Designed for controlling double acting hydraulic cylinders. The pilot cylinder is controlled by any type of 4-way air valve and is operated either automatically or manually from a convenient control station. Machined steel housing, hard chrome plated ground and polished stainless steel plungers, molded packers sealed by valve pressure. All parts readily accessible without disturbing the piping. ½" to 4" sizes. *Write for full details.*

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1911 East Pershing St., Salem, Ohio

ASR asked where to get a small handle button, wear-and-water-resistant . . . light enough to be set in plastic . . . produced in large quantities, quickly and inexpensively?

GRC* answered

Tiny GRC precision zinc die castings will make ideal handle buttons for the new Gem razor . . . meet to a T every ASR specification!

American Safety Razor's new Feather Weight Gem Razor weighing only 1 1/10 oz.

WITH GRC TINY PRECISION ZINC DIE CASTINGS

If obtaining really small parts speedily and economically is your problem, too, why not let GRC tackle it? Gries' revolutionary, high speed, mass production methods are geared to turn out simple or intricate parts in one automatic operation. Trimmed, ready for use . . . GRC zinc die castings as small as .000004 of a lb. in lots from 100,000 to millions . . . at a price to help you produce at a profit! Remember . . . it's GRC for *smallness unlimited.*

Write Today for Bulletin and Actual Part Samples.

MAX. WT. - ½ OZ.
MAX. LGTH. - 1¾"
SMALLNESS UNLIMITED

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AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. P.E.

NEW ADVERTISEMENTS received by 10 A. M. May 21st, in the N.Y.C. office, will appear in the June issue, subject to limitations of space available.

Special offer to

Design Engineers

Lockheed will pay you full salary while training you to be an Aircraft Engineer

...if you are a graduate engineer with approximately four years' layout and design experience in fields such as: Mechanical Product Design; Ship Design; Structural Steel Design, Metal Trailer, Bus or Railroad Car Design; Oil Refinery or Chemical Plant Design.

You will receive an important position in Aircraft Design upon successful completion of training.

Generous Travel Allowances are offered those who qualify.

Write today—giving full particulars as to experience and training.

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Karl R. Kunze, *Employment Manager*

LOCKHEED Aircraft Corporation

1708 Empire Ave., Burbank, Calif.

ENGINEERS

- Mechanical
- Aeronautical
- Product Design
- Test Engineers

THERE'S A BETTER JOB FOR *YOU* AT HAMILTON STANDARD

Leading engineering firm in an essential industry offers:

Immediate Openings • Excellent Pay
Finest Working Conditions • Opportunities for Advancement
Insurance and Retirement Income Plans

Hamilton Standard needs experienced engineers *now* to develop vital aircraft equipment.

Put your *own* ideas and experience to work at Hamilton Standard, top engineering firm in the field of aircraft equipment design and production.

Help develop supersonic equipment, cockpit air conditioning and other aircraft accessories and propellers.

Build your future with a sound engineering organization in a field with a bright future, both in military and commercial aviation.

Live and work in a pleasant, quiet community in the heart of beautiful New England. Settle your family where there are excellent schools . . . fine shopping districts . . . moderate living costs.

Let us have your resume now. State age, experience, qualifications, marital status, pay expected. *All replies will be answered.* Address Personnel Manager, Department M.

HAMILTON STANDARD

One of the Four Divisions of United Aircraft Corporation

EAST HARTFORD, CONNECTICUT

REPLIES (Box No.): Address to office nearest you
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CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

MECHANICAL ENGINEERS, graduate, with five to ten years experience in machine design and mechanisms. Openings are now available for several qualified men to handle mechanical research and development in textile mills as part of the research division for a large mill group. Previous textile experience not required. Salary and advancement commensurate with ability and experience. Location South Carolina. Give details including age, education, experience, marital status and present salary. All correspondence strictly confidential. Reply to P-8913, Product Engineering.

DRAFTSMAN, DESIGNER, wanted by hard-hitting, fast growing small organization, located in western Michigan, engaged in the manufacture of electronic and sound equipment. This position provides a chance to get in on the ground floor with good starting pay and the best possible opportunities for advancement. P-8994, Product Engineering.

WANTED: SALES Engineer. Must be Electrical Engineering Graduate. One who has had experience in contacting the Automotive Industry preferred. State salary desired and experience. All replies held in strict confidence. P-9318, Product Engineering.

POSITIONS VACANT

AXELSON MANUFACTURING Company, oldest and largest Machine Tool Builder in the West, has openings for qualified Machine Tool Design Engineers. If you are qualified and desire to make a permanent connection with an assured future in Southern California, write full details of your background to Axelson Manufacturing Company, Engineering Department, Box 15335, Vernon Station, Los Angeles 58, California.

EMPLOYMENT SERVICES

SALARIED POSITIONS $3,500 to $35,000. We offer the original personal employment service (established 41 years). Procedure of highest ethical standards is individualized to your personal requirements. Identity covered; present position protected. Ask for particulars. R. W. Bixby, Inc., 268 Dun Bldg., Buffalo 2, N. Y.

SALARIED PERSONNEL $3,000-$25,000. This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. H, 241 Orange St., New Haven, Conn.

Process Engineers

Process engineers to devise and install standard manufacturing procedures, control operating processes, instigate improvements and eliminate production "bottlenecks". Applicants should be mechanical engineering graduates with at least two years experience in the steel fabricating industry. Our company is a well-known steel fabricator, supplying utilities, industries and dealers with essential pipe line equipment; also produces special products and weldments for a variety of uses, including the transportation, aviation, and government procurement fields. Recent and contemplated expansion requires need for additional process engineering personnel. Recent college graduates in mechanical engineering interested in the manufacturing field as a career will be considered for positions as trainees. Send details of background and education to Personnel Manager.

Dresser Manufacturing Division
Fisher Avenue **Bradford, Pa.**

One of the Dresser Industries

PROJECT ENGINEERS
DESIGN &
DEVELOPMENT ENGINEERS
TECHNICAL WRITERS

AERODYNAMICISTS
Some stability experience desirable

ELECTRONIC DRAFTSMEN
For
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For
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ESSENTIAL INDUSTRIAL & GOVERNMENT PROJECTS

Challenging research, development and production programs are in process in the fields of flight simulation, television, radar, servo-mechanisms, aeronautics, computers, advanced armaments, and specialized machinery.

FAVORABLE WORKING CONDITIONS
Top Pay
Excellent opportunity for advancement on merit.

This Washington suburb has direct access to all the cultural, social, educational, recreational, and industrial facilities of our Nation's Capitol.
Housing is adequate in the Washington Area.

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Graduate M. E. with automatic mechanism design or development experience to handle automatic machinery development and maintenance problems. The machinery involved is complex precision equipment. Permanent position in Phila. area for manufacturing company of medium size (2000 employees). Please give details in your letter.

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Phila. 22, Pa.

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THE PROPERLY QUALIFIED ELECTRONIC LAYOUT & DESIGNER ENGINEER

. . . will fill a staff level position in the country's top guided missile telemetering firm. Should be familiar with airborne electronic equipment, JAN specifications, have at least 5 years experience.
Ability to Direct Group of Engineers, Model Shop. Write or call in person.

RAYMOND ROSEN
Engineering Products, Inc.
32nd & Walnut Sts. Phil. 4. Pa.

FOR
INDUSTRIAL MODELS
Write E. G. HOWLAND
609 MICHIGAN AVE. TROY, OHIO

FOREMAN

Leading die casting firm employing over 100 men in plant. Needs foreman with experience on zinc and aluminum die casting machines. Knowledge of production controls, foundry and alloying necessary.

Conveniently located in New York Metropolitan area near all transportation. Liberal employee benefits. Write for interview giving employment record and salary desired. All replies held in strictest confidence.

P-9337, Product Engineering
330 W. 42 St., New York 18, N. Y.

SMALL MANUFACTURES

Nebraska town 1400 population on CB&Q would like to contact manufacturer seeking location. Can make concessions on light, power, water, heat and building. In center of new irrigation district. Principals only. Your reply will bring any wanted information.

T-9368, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

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PRODUCT ENGINEER: engineering executive 20 yrs. design & development experience on small electro-mechanical devices. Several patents. Tool & production experience. Now Ch. Eng. of med. small plant. PW-7295, Product Engineering.

BUSINESS OPPORTUNITY

Finance required
to market fully automatic turn and slow signal device. Simple design, easily produced in high quantities. Fully patented. BO-9407, Product Engineering.

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CONSULT: Z. H. POLACHEK,
Reg. Patent Attorney, 1234 Broadway, New York 1, N. Y.

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Cost Reduction Studies: Process or Product. Redesign Existing Products for Greater Profit. Trouble Shooting Production, Design, Cost Problems. Specialist Automatic Machinery, Processes, Controls, New Developments, Patent Studies, Investigations, New Products & Process Engineering Studies.
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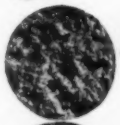

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NON-GRAN
CASTINGS • SAND & CENTRIFUGAL

An Investment !

Productive advertising is an INVESTMENT rather than an EXPENDITURE.

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PRODUCT ENGINEERING
330 WEST 42nd STREET
NEW YORK 18, NEW YORK

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PRODUCTS ADVERTISED

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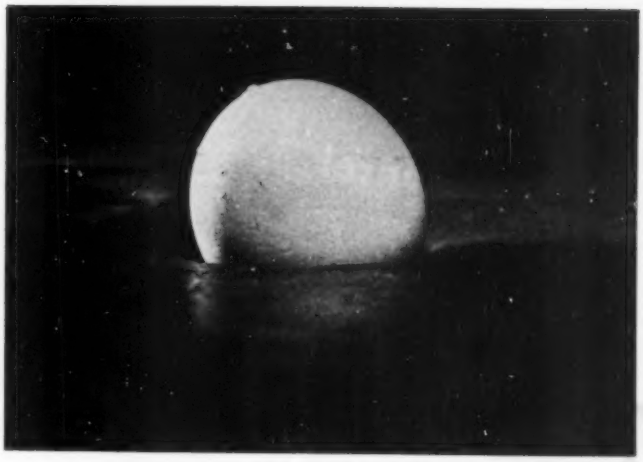

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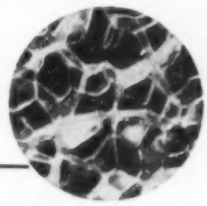

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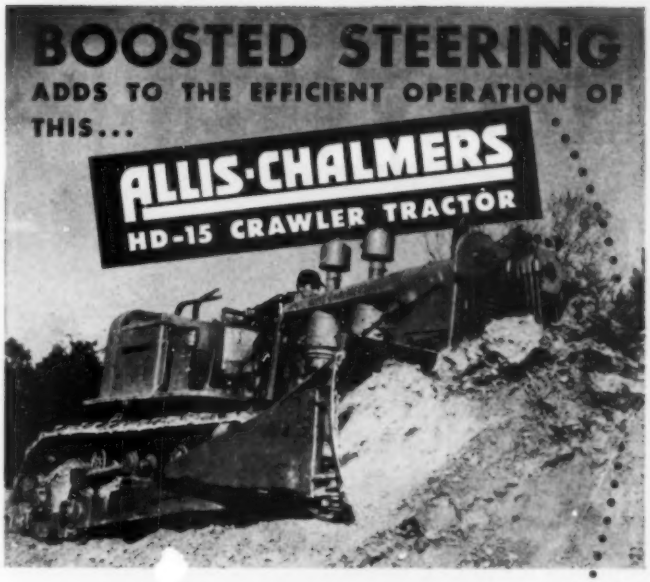

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HYDRAULIC BOOSTER FOR STEERING

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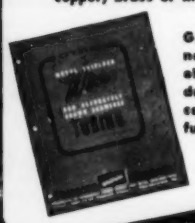

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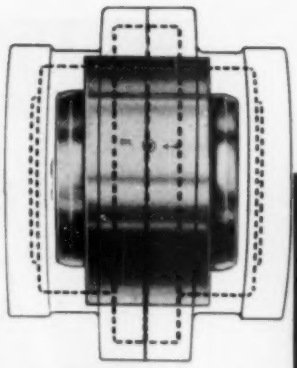

Sier-Bath Gear Coupling compared with two major conventional types of same shaft size. Through all sizes, Sier-Bath's HP capacity is greater than either.

- 3/5 Usual Size
- ½ Usual Weight
- Assembled in Seconds

NEW Sier-Bath Flexible GEAR COUPLING

Ready for Assembly

ONLY 7 PARTS!

1—Slide Sleeve over Hubs . . .

2—Press in Seal . . .

3—Snap in Snap Ring!

THIS NEW, simplified gear coupling makes possible lighter, more compact designs, allows faster assembly, and provides better protection for coupled equipment. A one-piece smooth sleeve replaces the conventional heavy flanges, and instead of the usual nuts and bolts, the sleeve is held on the hubs by a simple seal and snap ring arrangement. Thus the new coupling is smaller and lighter, and can be assembled in a fraction of the time.

This simplification does not alter the basic flexibility of the gear type. The Sier-Bath Coupling handles the usual amount of angular and offset misalignment, and end float. And, being smaller and lighter, it puts less strain on shafts and bearings.

With no bolts to shear, seize, strip or corrode, the new coupling is more dependable and durable. Though the snap rings are installed by hand and removed with a small screw driver, they will withstand 50,000 lbs. of end thrust. The neoprene seals are *guaranteed* leak-proof—the hubs and sleeve are made from steel forgings with 90,000 lbs. tensile strength. Silent operation and long life are insured by precision cut internal teeth, and the design provision that *all* the load is carried on *all* the teeth *all* the time.

WRITE FOR BULLETIN!

Gives installation photos, complete list of cost-cutting advantages, detailed plan drawings and specifications for standard, vertical, mill motor, spacer and floating shaft types—sizes from ⅜ to 6, HP 4 to 550. (Special sizes and types on request).

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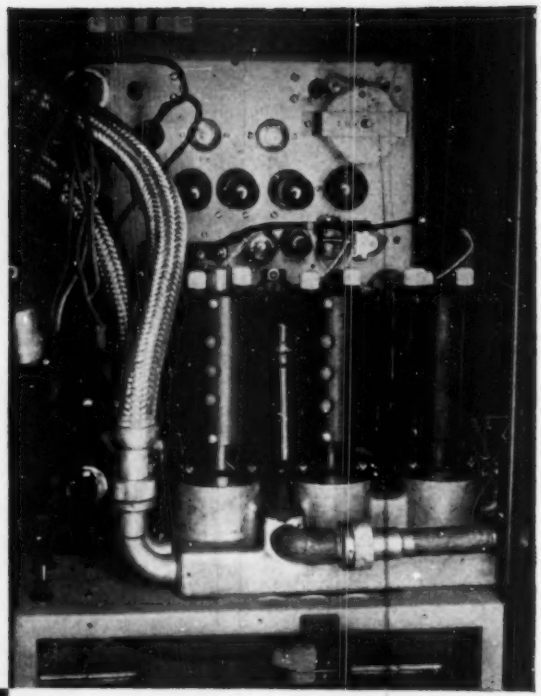
Sier-Bath GEAR and PUMP CO., Inc.

9238 Hudson Blvd., N. Bergen, N.J.

Also Manufacturers of Precision Gears and Gearex and Screw Pumps

RCA

uses flexible connectors for RIGID performance



The famous RCA Electron Microscope enables man to magnify the infinitesimally small on a scale that would make a postage stamp appear the size of a ball park. It does it with a beam of electrons, themselves so small that even a molecule of air may deflect them.

This calls for high vacuum—a vacuum of only 1/10,000,000 of an atmosphere. The connections between the pumps that create this vacuum and the vacuum chamber of the microscope must be flexible for reasons of assembly, minimized vibration and ease of adjustment. So RCA engineers specified seamless flexible metal tubing.

This is a dramatic example of how American Seamless Flexible Metal Hose and Tubing – tight, strong and corrosion resistant – can provide *flexible* connectors for almost any liquid, gas or semi-solid; can connect piping or parts that vibrate, move or are out of alignment. 81255

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From mine to consumer

wherever connectors must move **American**

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Master Speedrangers provide this infinitely variable speed in an all-metal, mechanical variable speed unit whose compactness and durability are extra features which help you make a good job better. And nowhere else will you find variable speed drives that are so flexible, so easily adaptable and in such a wide range of types and sizes.

makes a good job better

again and again variable speed operation

For example, look at the plastic forming machine shown below. The Speedranger, on the drive unit incorporates an electric motor, a variable speed unit and a gear reduction . . . all standard Master units that easily combine into one compact, integral power package. This provides exactly the right speed, the right features, in a unit that you can mount right where you want it.

Probably you will not need this same combination of features. However, the next time you need a drive for material processing, handling, and conveying equipment; mixers and agitators; welding-positioners; machine tool drives; testing and calibrating equipment . . . to name only a few . . . see what a really remarkable job Master Speedrangers can do for you. Write for Data 7525, new twenty-four page booklet on Speedrangers.

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DAYTON 1, OHIO

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MASTER SPEEDRANGERS

For high precision gear trains TIMKEN® bearings are just the ticket

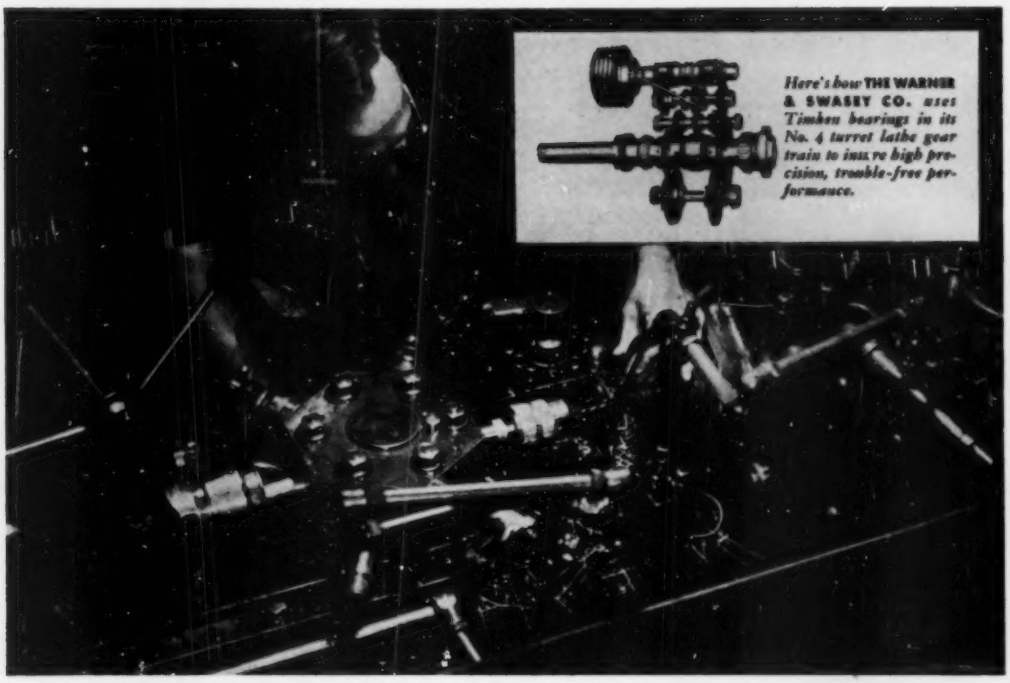
THE No. 4 Warner & Swasey turret lathe shown below is machining precision parts for airplane engines. To insure the high precision called for, Warner & Swasey uses Timken® tapered roller bearings on the spindle and throughout the gear train.

Because Timken bearings are tapered, they take any combination of radial and thrust loads. And due to the line contact between rollers and races, Timken bearings provide extra load carrying capacity. Result: Shaft deflection and end-movement are minimized. Shafts are held in rigid alignment. Gears mesh smoothly. Spindle precision is assured day in, day out.

Timken bearings are made from Timken fine alloy steel—the finest ever developed for tapered roller bearings. Rollers and races are case hardened, producing hard, wear-resistant surfaces and tough, shock-resistant inner cores. True rolling motion and smooth surface finish combine to make Timken bearings practically friction-free. They normally last the life of the machine in which they're used.

For the best value in machine tools look for the "Timken bearing equipped" label. For the best value in bearings look for the trade-mark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Here's how **THE WARNER & SWASEY CO.** *uses Timken bearings in its No. 4 turret lathe gear train to insure high precision, trouble-free performance.*

IT'S TIMKEN BEARINGS FOR VALUE!

To get the best value in bearings you may find this simple formula helpful:

$$Value = \frac{quality + service + public\ acceptance}{price}$$

Obviously a big advantage *above* the line gives you more value than a small one *below*. No other bearing can match the uniform high quality, engineering and field service and overwhelming public acceptance you get with Timken bearings.

TIMKEN

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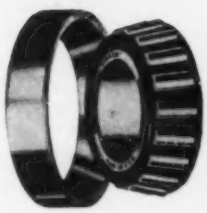
TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ⊡ AND THRUST →⊡← LOADS OR ANY COMBINATION ✳